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EPA Project Officer: Diana King
EPA Remedial Project Manager: David Lederer

INTERIM FINAL FEASIBILITY STUDY

Hatheway & Patterson Superfund Site
Mansfield/Foxborough, Massachusetts

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Prepared By:

Metcalf & Eddy, Inc.
701 Edgewater Drive
Wakefield, MA 01880

Team Subcontractor
TRC Environmental Corporation
Boott Mills South
Foot of John Street
Lowell, MA 01852

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1.0 INTRODUCTION

Metcalf & Eddy of Wakefield, Massachusetts (M&E) received Work Assignment (WA) No. 045-RICO-01N9 under the United States Environmental Protection Agency (USEPA) Response Action Contract No. 68-W6-0042 (RAC) to complete a Remedial Investigation/Feasibility Study (RI/FS) at the Hatheway & Patterson Superfund Site (Site) in Mansfield and Foxborough, Massachusetts. M&E assigned the primary responsibility for completing most of the RI/FS to TRC Environmental Corporation of Lowell, Massachusetts (TRC).

1.1 Purpose and Scope

The purpose of this report is to identify and evaluate remedial technologies to address both source control and management of migration remedial action objectives (RAOs). The results of this FS will be used by USEPA to select a preferred remedy, and ultimately a Record of Decision (ROD).

The FS report was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (CERCLA); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40 CFR 300; and the "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA".

Engineering cost estimates were prepared as part of the FS process. The cost estimates presented in this report were prepared for comparison purposes according to EPA guidance; actual costs may vary. More detailed cost estimates will be prepared as part of the Remedial Design/Remedial Action (RD/RA). This FS did not include conducting treatability studies or preparation of design documents. In addition, the FS is not intended to be a stand-alone report, and the Remedial Investigation Report (RI) should be referred to for more detailed information.

1.2 Background

1.2.1 Site Location

Figure 1.2-1 shows the location of the Site in the Towns of Mansfield and Foxborough, Massachusetts approximately 30 miles southwest of the City of Boston, Massachusetts at 42° 2' 14.8" north latitude and 71° 13' 19.0" west longitude.

The Hatheway & Patterson Superfund Site is located on 35 County Street in Mansfield, Bristol County, Massachusetts. Approximately 36 acres of the 38.17-acre Site are located in the Town of Mansfield. The remaining 1.77 acres are located in the Town of Foxborough. The Site is a former wood preserving facility owned and operated by the Hatheway & Patterson Company. Operations ceased in 1993, when the company declared bankruptcy. The Town of Mansfield currently owns the majority of the Site. The portion located in Foxborough is still owned by the Hatheway & Patterson Company.

1.2.2 Site Description

Figure 1.2-2 shows the layout of the Site. The Site is bordered to the north by County Street and residential properties, to the south and west by residential areas, and to the east by commercial and industrial properties. The property is bisected by the Rumford River, which runs north to south, and by a railway right-of-way, which runs east and west. The majority of the Site is zoned for industrial mixed use (I-3). The parcel located in Foxborough is in a Residential and Agricultural District (R-40). Parcels surrounding the Site include both businesses and residential properties. The railroad tracks and the Rumford River divide the Site into four quadrants , as shown on Figure 1.2-2. For the purposes of this FS, the NE and NW quadrants are referred to as the “Process Area”, the “SE/SW Quadrant” is the area south of the Rumford River, and the “County Street area” lies north of the Site fence, in the NE and NW quadrants. The Site and surrounding area are served by municipal drinking water.

The majority of the historical operational areas and buildings are located on the northern portion of the property, north of the railroad tracks. This “Operations Area” (also referred to as the “Process Area,”) contains process buildings, three drip pads, support buildings, an office, and a laboratory.

Areas of the Site that are south of the railroad tracks are generally level as a result of filling activities, and were used for storing treated wood. Wood Storage Area 1 is located north of the railroad adjacent to the Process area. Wood Storage Areas 2 and 3 are located on the southern side of the railroad tracks. Two former wood storage buildings were located in the southeastern portion of the property. Two small hills (approximately 15 and 50 feet high) are located on the southeastern portion of the property and a bedrock outcrop (approximately 20 feet high) is also present in this portion of the property. An abrupt topographic drop of approximately 10 to 20 feet extends in an east-west orientation, along the southern edge of the fill line. The area south of the fill line is topographically lower, densely wooded, contains wetlands and is bounded by the Rumford River backwash channel. The Rumford River backwash channel was created after re-routing of the Rumford River between 1951 and 1956.

1.2.3 Operational History

Initially, the Hatheway & Patterson property consisted of only the land between County Street and the railroad tracks, and the land from the present eastern property boundary to approximately the Rumford River (Figure 1.2-2). The land west of the Rumford River was owned by the Penn Central Railroad, who used it for bulk chemical transfer and storage of electric/utility poles and railroad ties. This piece of land was purchased by Hatheway & Patterson in 1978. The land south of the railroad tracks was purchased by Hatheway & Patterson in 1981. This portion of land was apparently not used between 1955 and 1971, but prior to 1955 the area was reportedly used for coal storage.

Operations at the Site included the preservation of wood sheeting, planking, timber, piling, poles and other wood products. Reports indicate that Hatheway & Patterson began operations at the Site in 1927, but that wood treating did not begin until 1953. It is unknown what operations might have been conducted on Site between 1927 and 1953.

Wood treatment was accomplished by a variety of methods that changed over time. From 1953 through 1958, a solution of pentachlorophenol (PCP) in fuel oil, or creosote, was used for dipping lumber. After dipping, excess chemicals were allowed to drip off of the treated wood onto the ground surface. From 1958 through 1974, solutions of PCP in fuel oil and fluoro-chrome-arsenate-phenol (FCAP) salts in water were used in a pressure treatment process. From 1960 through 1984, PCP in mineral spirits was also used to pressure-treat lumber. From 1974 to 1984, operations incorporated PCP in fuel oil and chromated copper-arsenate (CCA) salts in water. From 1984 until operations ceased in 1993, solutions of CCA salts in water and PCP in water were utilized at the property. Wood was also infused with fire retardants including Dricon™ (boric acid and anhydrous sodium tetraborate). The various wood-treating chemicals were stored in aboveground storage tanks (ASTs), underground storage tanks (USTs), and sumps located inside and outside of the former process buildings (MADEP, 1994).

1.2.4 Previous Investigations

<u>State Actions</u>

In 1972, a tar seep (approximately 62 feet long and 6 inches thick) was discovered on the banks of the Rumford River on the southern portion of the property (exact location unknown) by representatives of the Town of Mansfield and the Massachusetts Department of Environmental Quality Engineering (MADEQE). Additionally, "oily water" and dead fowl were reported in Fulton Pond (the Rumford River discharges into and exits Fulton Pond downstream of the property). Subsequently, MADEQE and the Town of Mansfield requested Hatheway & Patterson to contain the "oily seepage", which appeared to originate from the eastern bank of the Rumford River adjacent to the Hatheway & Patterson Company (HPC) property (DynCorp, 2001).

Hatheway & Patterson took steps to control the "oily seepage" with deep water booms and sorbents. In 1973, test wells, as well as a collection pit and a collection trench, were installed to pump oil-contaminated ground water. By the summer of 1973, oil seepage reportedly ceased; however, later in the year, seepage appeared farther downstream. As a result, Hatheway & Patterson installed a treated plywood bulkhead to trap the seepage and continued removing oil with sorbents. In 1974, an "L-shaped non-permeable" barrier was installed with four recovery pits along the River. Ground water pumping operations were conducted from approximately 1973 through 1982 (DynCorp, 2001).

In 1981, an "oily seepage" was again observed in the Rumford River. A prospective buyer of the property conducted soil and ground water sampling on the property. Analyses of the samples revealed "oily soils and/or oily ground water." As of 1982, approximately 2,500 gallons of oil had been recovered through the ground water pumping operations (DynCorp, 2001).

In May 1987, following an on-site reconnaissance, MADEQE issued a Notice of Noncompliance (NON) letter to Hatheway & Patterson. The NON required Hatheway & Patterson to complete a Phase I Initial Site Investigation (Phase I) pursuant to Massachusetts General Law (MGL), Chapter 21 E, Sections 4 and 5 (DynCorp, 2001).

In November 1987, Keystone Environmental Resources, Inc. (Keystone) of Monroeville, Pennsylvania conducted a Soils and Hydrogeologic Investigation (i.e., a Phase I) of the property. The investigation consisted of 11 soil borings on the property and nine monitoring wells (DynCorp, 2001).

Keystone collected 18 soil samples from various depth intervals. All of the soil samples were analyzed using EPA laboratory methods. Three VOCs, 16 PAHs, 12 phenolic compounds, and the three metals were detected in the soil samples (DynCorp, 2001).

Two rounds of ground water sampling (January and March 1988) were also completed as part of the Phase I. Three surface water samples were also collected from the Rumford River. (DynCorp, 2001).

Laboratory analysis of the ground water samples revealed the presence of 17 PAHs and 12 phenolic compounds. VOCs including xylenes, 1,4-dichlorobenzene, and ethyl benzene, and metals including arsenic, chromium, and copper were also detected in the ground water samples. Benzene and phenol were detected in surface water samples collected above-plant and below-plant, respectively (DynCorp, 2001).

As a result of ground water pumping by Hatheway & Patterson in the mid-1970s, several drums of recovered oil were stored on the property along the east bank of the Rumford River, approximately 175 ft south of the railroad tracks. According to Keystone, at an unknown date, vandals reportedly shot holes in the drums, tipped the drums over, and allowed the oils to seep into the ground and the River (DynCorp, 2001).

After review of the Phase I report, MADEQE issued a Notice of Responsibility (NOR) letter to Hatheway & Patterson in August 1988. The NOR required Hatheway & Patterson to complete a Phase II Site Investigation (Phase II), a Risk Assessment, and an alternative evaluation (DynCorp, 2001).

In late 1988 and early 1989, on behalf of Hatheway & Patterson, Keystone performed a Phase II investigation of the property. The investigation consisted of six more soil borings, seven more monitoring wells, as well as installing two piezometers (P-1 and P-2, not found during RI investigations) and one pump test well (PW-001) (DynCorp, 2001).

A total of 14 soil samples were collected from various depth intervals during soil boring advancement, and monitoring well, piezometer, and pump test well installation. Three ground water sampling rounds were conducted in February, March, and April 1989 as part of the Phase II. In addition, Keystone collected three surface water samples, and nine sediment samples from areas north and south of the Rumford River backwash channel (DynCorp, 2001).

Laboratory analysis of the soil and ground water samples revealed the presence of VOCs, phenolic compounds, PAHs, chromium, copper, and arsenic. Phenolic compounds and PAHs were also detected in surface water and sediment samples. The only VOC detected in the sediment samples was toluene, which was present in all the sediment samples. No VOCs were detected in the surface water samples (DynCorp, 2001).

In June 1990, after a period of heavy rainfall, “oily seepage” was again reported on the Rumford River in the vicinity of the HPC property. As a result, the Massachusetts Department of Environmental Protection (MADEP), formerly MADEQE, issued a Request for Short Term Measure (STM) letter to Hatheway & Patterson to address the imminent hazard to the Rumford River area caused by on-site operations (DynCorp, 2001).

In the fall of 1990, Keystone conducted a STM investigation. The investigation included the “sampling of the worst-case visibly stained soil along the river bank”. Keystone reported that the results of the analyses indicated that the major constituent of the seepage to the River were semivolatile organic compounds (SVOCs). Oil and odors were also reported in some of the soil samples (DynCorp, 2001).

In September 1991, Hatheway & Patterson constructed a collection trench along the eastern bank of the Rumford River. Contaminated ground water recovered from this trench was used by HPC as process make-up water. The collection trench was designed to intercept ground water and oils migrating to the River from the oil-contaminated portion of the River bank. Some soil was excavated during the STM and stockpiled on Site (DynCorp, 2001).

In February 1992, Penney Engineering, Inc. (Penney) of Mansfield, Massachusetts began monthly monitoring of the collection trench. Penney retrofitted the trench to include a ground water treatment system consisting of activated carbon canisters prior to discharging the ground water to the Rumford River (DynCorp, 2001).

In January 1993, MADEP conducted an inspection of the property, and reported observing petroleum product flowing from the River bed into the River, a release of oil into nearby wetlands, and free-floating product in the wetlands. As a result, MADEP requested HPC to conduct an additional assessment and develop plans for corrective action at the property (DynCorp, 2001).

In February 1993, Hatheway & Patterson filed for bankruptcy protection. In April 1993, manufacturing operations ceased at the property. The HPC facility closed on May 21, 1993, leaving wood-treatment chemicals and sludge in ASTs, UST sumps and drums at the abandoned property (DynCorp, 2001).

Federal Actions

In March 1992, two RCRA inspections were conducted at the property to determine compliance with RCRA drip pad standards. The inspections revealed that drip pads were riddled with cracks, seams, gaps, and corroded areas in the concrete, and that portions of the drip pads were not curbed or bermed. The inspection concluded that these drip pads were not in compliance with RCRA regulations (DynCorp, 2001).

On June 22, 1993, EPA Region I Emergency Planning and Response Branch (EPRB), MADEP, and Weston personnel initiated a Preliminary Assessment/Site Investigation (PA/SI) at the HPC property. (DynCorp, 2001).

On July 15, 1993, the ground water treatment system operations were terminated. At that time it was concluded by MADEP that the ground water, surface water, and River sediments were contaminated with PCP. MADEP also determined that a PCP- and CCA-contaminated ground water plume was moving south into the adjacent wetlands and the Rumford River backwash channel. In addition, non-aqueous phase liquid (NAPL) was observed in monitoring wells that had previously been free of NAPL (DynCorp, 2001).

On December 7, 1993, based on the results of the PA/SI, EPA initiated an Emergency Removal Action (ERA) due to the presence of ASTs and USTs containing hazardous wastes located inside and outside the buildings, and the possibility of a release if the tanks and/or pipelines froze and ruptured during cold weather (DynCorp, 2001).

Activities conducted during the ERA included the characterization of chemical wastes (Dricon™, CCA, and PCP) stored in the ASTs, USTs, vessels, and drums on the property. A total of 32 ASTs and USTs were identified on the property. Sludge samples collected from the ASTs and USTs revealed the presence of six VOCs, five SVOCs, 11 metals, dioxin/furan congeners, pesticides and polychlorinated biphenyls (PCBs). All virgin wood-treating solutions were shipped to other wood-treating facilities. Approximately 100,000 gallons of liquid and solid wood-treating wastes were drummed and/or pumped into tank trucks and shipped to appropriate hazardous waste disposal facilities (DynCorp, 2001).

On December 12, 1993, the HPC property was added to the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database (DynCorp, 2001).

A comprehensive surface soil investigation was conducted as part of the ERA in 1995. Soil samples were collected from a variety of areas on the property and screened on site for arsenic. Based on the elevated concentrations of arsenic detected, several areas of the property received temporary geotextile/gravel and/or asphalt cover (DynCorp, 2001).

Additional operations conducted as part of the ERA included repair and installation of fencing around the perimeter of the property, installation of locks to manways of tanks, and installation of locks to on-site buildings. ERA operations continued until September 1995. Following the ERA, MADEP-Southeast Region assumed oversight of the property (DynCorp, 2001).

An April, 1998 on-site reconnaissance of the property noted the presence of stained drip pads, oily sheens in the River, and oily outbreaks in the soil in the southern portion of the property, and a deteriorating plastic cover on a soil pile. MADEP-SE personnel collected six samples from the property in June, from ground water, surface water, sediment from the Rumford River adjacent to the concrete retaining wall, soil/sediment from an oily seep outbreak area along the southern fill line, and surficial soil. Analytical data from these samples indicated elevated of dioxins and furans in sediment (DynCorp, 2001).

On October 16, 1998, EPA collected 12 sediment samples and five surface water samples from the Rumford River at locations upstream, adjacent, and downstream of the property, including

Fulton Pond and Kingman Pond. The samples were collected to determine if there had been any migration of hazardous substances from the property to surface water. In addition, EPA collected six surficial soil samples from the property (DynCorp, 2001).

One SVOC, 16 dioxin/furan congeners, and two metals were detected in sediment samples; five dioxin/furan congeners were detected in surface water samples; and five SVOCs, 16 dioxin/furan congeners, and five metals were detected in soil samples (DynCorp, 2001).

On November 23 1998, EPA collected seven fish tissue samples from the Rumford River (downstream of the HPC property) to determine the potential for bioaccumulation of PCP, dioxin/furan congeners, and arsenic in fish tissue. PCP and a total of seven dioxin/furan congeners were detected in the fish tissue samples. Arsenic was not detected in any of the fish tissue samples (DynCorp, 2001).

In 2000, the Town of Mansfield conducted an environmental investigation at the Site (performed by Resource Controls) under the Town of Mansfield's EPA Brownfields Pilot Program. The study included installation of nine overburden ground water monitoring wells, two bedrock ground water monitoring wells, sampling of surface water, sediment, soil and ground water. Findings confirmed earlier studies indicating dioxin, arsenic and PCP contamination in surface soil, LNAPL (Light, Non-Aqueous Phase Liquid)[1] south of the railroad tracks, ground water contamination including arsenic and PCP, and sediment contamination. (DynCorp, 2001).

In fall 2001, EPA's contractors sampled 15 existing ground water wells, and surface water/sediment from 19 locations in the Rumford River and two vernal pools. The results indicated the presence of a ground water plume containing arsenic and PCP extending from the Process Area to the Rumford River, and a possible second ground water plume emanating from the southern portion of the Site. Elevated concentrations of arsenic, lead, PCP and dioxin were detected in sediment adjacent to the Site and elevated concentrations of PCP were detected in surface water at the Site (DynCorp, 2001).[2]

In April 2003, the EPA laboratory analyzed several surface soil samples taken outside of the perimeter fence to determine whether there was any off-site arsenic contamination. Samples were obtained on both sides of County Street. Some samples contained arsenic in excess of 30 ppm (DynCorp, 2001).

In August 2003, the EPA initiated an Emergency Removal Action to address the off-site arsenic-contaminated soil identified in the April 2003 investigation. A total of 376 tons of soil was removed from both sides of Country Street. The excavations were lined with geotextile and

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[1] Non-aqueous phase liquids are hydrocarbons, such as oil, which have a low solubility and therefore exist as a separate, immiscible phase when in contact with water or air. Often, NAPLs are mixtures of organic contaminants with varying degrees of solubility. See *Ground water Issue Paper: Light Nonaqueous Phase Liquids* EPA, (July 1995) for more information.

[2] It should be noted that the substrate in the vernal pools at the site can be considered "sediment" for only several weeks in early spring when the pools are filled with water. For the remainder of the year, the vernal pools are dry and their substrate should more accurately be considered as "soil". However, in the discussions that follow, the vernal pool substrate is only referred to and discussed as "sediment."

backfilled with clean soil (Weston, 2004). The soil was disposed of at an off-site licensed facility**.**

1.3 Site Conditions

1.3.1 Geology/Hydrogeology

The Rumford River divides the Site into eastern and western portions. The River flows generally from north to south within the main facility area. A short reach of the River, now abandoned, is referred to as the backwash channel. The bridge area through which the present channel flows is lined with granite blocks.

According to Massachusetts law (314 CMR 4.00), the Rumford River is a Class B surface water. Class B waters are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Where designated, Class B waters are suitable as a source of public water supply with appropriate treatment. Class B waters are also suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. Class B waters shall have consistently good aesthetic value.

Based on the Flood Insurance Rate Map, portions of the Site are located within areas of the 100-year flood zone (Zone A3) and between limits of the 100-year flood and 500-year flood zone (Zone B) for the Rumford River.

The Rumford River's downstream water pathway flows through Fulton, Kingman, and Cabot Pond and then into the Norton Reservoir at approximately 3.5 miles from the Site. The River exits the reservoir on the southeast side and joins with the Wading River at approximately 8.7 miles from the Site, which joins with the Three Mile River at approximately 1 mile southeast. The 15 mile water pathway ends approximately 5 miles down the Three Mile River, which eventually flows into the Taunton River.

The average annual depth to ground water underneath the Site is generally less than 15 feet; at locations where bedrock was found closer to ground surface, the saturated interval was elevated, generally 3 feet to 6 or 7 feet below grade. Ground water flow direction on the property, both in the overburden and bedrock, is generally southwesterly, toward the Rumford River. Ground water appears to discharge to the Rumford River. A low laying marsh area, the Rumford River backwash, is located just south of the southern Site boundary.

1.3.2 Current and Future Use

<u>Land Use</u>

The majority of the Site is located in Mansfield and currently zoned as I-3. This is a flexible mixed-use industrial zone that allows an array of uses from heavy manufacturing to multi-family dwellings to day care. Currently, the Town of Mansfield utilizes a portion of the Site north of the railroad tracks for storage of emergency vehicles and uses one remaining existing office building; the remainder of the property is unoccupied. The Site has been used for commercial/industrial purposes intermittently since 1927 (Reuse Assessment, TRC, September, 2003). The area of the Site south of the railroad tracks has historically been used for storage but not developed.

On March 31, 2005, the Town of Mansfield notified EPA (Appendix A) that the reasonably anticipated future land use (RAFU) of the portion of the Site located in Mansfield will be commercial use for the front parcel located on County Street (north of the railroad tracks) and Open Space or Commercial, whichever is considered the higher standard of cleanup, for the back parcel (south of the railroad tracks). In their letter, the Town understands that necessary and appropriate deed restrictions will be placed on the property in accordance with the RAFU which establishes a basis of the allowable uses given the standard of cleanup for the Site.

The 1.77 acre portion of the Site located in Foxborough is in a Residential and Agricultural District (R-40). (See Reuse Assessment, TRC 2003). The district is established to promote agricultural uses and low-density residential uses and to allow other selected uses that compatible with the open and rural character of the district. The town of Foxborough has not indicated what the reasonably anticipated future land uses of this approximately 2 acres will be or when this will be determined. Currently, the parcel is unused and during Hatheway & Patterson operations it may have been used for wood storage. The FS assumes the future use to remain residential.

Ground Water Use

The Site and surrounding area are currently served by municipal drinking water. The Massachusetts Department of Environmental Protection has issued a 'Ground water Use and Value Determination' for the Site (Appendix B). In part the document stated:

> *"The ground water beneath and in the vicinity of the Site is not classified as a current or potential drinking water supply. The closest municipal water supply wells are located approximately one mile to the east. An approved Zone II extends to approximately one-quarter mile to the east of the Site. There is an EPA designated Sole Source Aquifer also located approximately one-quarter mile to the east. Wetland areas are located to the east, northeast and southwest of the Site. The aquifer underlying the Site is classified as low yield by the United States Geological Survey (USGS). The Site Area aquifer is classified as both GW-2 and GW-3 (see description below).*
>
> ***GW-2*** *This designation addresses areas where there is a potential for migration of vapors from ground water to occupied structures. The classification applies to locations where ground water has an average annual depth of 15 feet or less and where there is an occupied building or structure within a 30-foot surface radius of that ground water.*
>
> ***GW-3*** *This designation considers the impacts and risks associated with the discharge of ground water to surface water, and therefore applies to all ground water.*

Considering this determination and the Site conditions, the ground water risk evaluation and cleanup decisions should consider, but not be limited to the following:

Human Health:	*a) vapor seepage into buildings,* *b) Site excavation activities that may expose workers to contaminated ground water and vapors,* *c) discharge to surface water and potential exposure routes (e.g. wading, other recreational activities) potential for migration of contaminated ground water to areas of higher ground water use and value.*
Ecological	*a) effects to wetlands and river biota.*

In light of the use and value factors and similar criteria established in the MCP that were examined in this determination, the Department recommends a <u>low use and value</u> for the Site ground water. "

The Massachusetts DEP's Use and Value Determination stated that "on-site businesses use public water" and are "not expected to use Site water for non-potable uses." Based on this information, any future use of the Site, whether for recreational, commercial, or even residential purposes, would be supported by municipal water and would not require use of the aquifer for potable uses. Therefore, the Remedial Action Objectives in this FS have been designed to protect GW-2 and GW-3 uses as well as protecting ecological resources. RAOs for ground water will also be designed to be consistent with the Town of Mansfield's Reasonably Anticipated Future Use of the Site and the Town of Foxborough's zoned use of the Site.

1.3.2 Ecology

Figure 1.3-1 shows the approximate location of the three main habitats together with the wetland boundary observed on and adjacent to the Hatheway & Patterson Site.

- forest (palustrine and mixed upland)
- successional field
- aquatic (riverine and open water).

Figure 1.3-1 also shows the location of potential vernal pool habitat areas in the southern portion of the Site. All potential vernal pools were formed in natural swales or depressions; VP-C2 was formed in the pit resulting from a tree blowdown. Substrate in each pool consisted of a leafy layer overlying a spongy forest floor that; when disturbed, the substrate often emitted a sulfur odor. At the time of the survey, much of the forest floor was saturated or inundated. However, many inundated depressions were not classified as vernal pools because at the time of the survey, the depressions contained outlets that connected to the Rumford River or its backwash channel, and were therefore susceptible to fish activity. Further study will be conducted during remedial design to determine if the potential vernal pools meet Massachusetts criteria for vernal pools.

According to correspondence from the US Fish and Wildlife Service (letter provided in Appendix C)**:**

"No federally listed or proposed, threatened or endangered species under the jurisdiction of the US Fish and Wildlife Service are known to occur in the project area, with the exception of occasional transient bald eagles. "

According to the correspondence from the Commonwealth of Massachusetts Division of Fisheries and Wildlife (letter provided in Appendix D) **:**

' the Site is near Priority/Estimated Habitat PH 1216/WH 6067, which has been delineated for the Blue-spotted salamander (Ambystoma laterale), a species of special concern in Massachusetts , and the Spotted Turtle (Clemmys guttata) also a species of special concern. The Site is also near Priority Habitat PH 1203 which has been delineated for the Southern Hairstreak (Fixsenia favornius), a species of special concern.'

1.4 Nature and Extent of Contamination

The following sections describe the nature and extent of contaminants of concern in the areas investigated during the Remedial Investigation. Figures 4.1-1 through 4.6-1 of the Remedial Investigation show the location of contamination in each media and their concentrations.

1.4.1 Surface Soil

Pentachlorophenol, PAHs, arsenic, and dioxin were detected in soil at various locations on the Site. The highest concentrations of PCP were detected in the Process area in vicinity of the Cylinder No. 01 and 02 Building, at 4,900 mg/kg. The highest concentrations of PAHs were detected in samples SS-030 and SS-031, located on County Street across from the Site. The highest on-site concentrations of PAHs were detected at SS-022 located in the northwest portion of the Site in the vicinity of the drying area.

The highest concentrations of arsenic (1,860 mg/kg) was detected at location SS-058 in the vicinity of the Cylinder No. 03 Building and CCA drip pad. Elevated concentrations of arsenic (1,200 mg/kg) was also detected in surface soil sample HP4-G, located adjacent to the Cylinder No. 01 and 02 Building. An elevated concentration of arsenic was also detected at HP1-M5, located in the northwest portion of the Site in the vicinity of the drying area, at a concentration of 630 mg/kg.

The highest concentrations of dioxin in surface soil were detected in the Process area in the vicinity of the PCP drip pad in surface soil sample SS-005 at a concentration of 11,000J ng/kg.

1.4.2 Subsurface Soil

Pentachlorophenol, arsenic, and dioxin were detected in subsurface soil at various locations on the Site. The highest concentration of PCP was detected in the vicinity of the PCP drip pad in sample GP-013 (2-4 feet) at a concentration of 1,100 mg/kg. Elevated concentrations of PCP were also detected at deeper depths (6-8 feet) in the Process area and on the south side of the railroad tracks; 490 mg/kg near the kiln building and 710 mg/kg west of the former wood storage building paved area.

The highest on-site concentrations of arsenic in subsurface soil (540 mg/kg) were detected in the Process area at location GP-012 (2-4 feet) located northeast of the CCA drip pad. Elevated arsenic concentrations were also detected in sample MW-003 (6-8 feet) at 140 mg/kg, located at the edge of the PCP drip pad and in sample RCA-6 (4-6 feet) at 60 mg/kg, located next to the CCA sump. The highest concentration of arsenic on the south side of the railroad tracks was detected in sample SB-010 (1-4 feet) at 55.1 mg/kg, located at the edge of the paved area.

Elevated concentrations of dioxin in subsurface soil were detected in both the Process area and south of the railroad tracks next to a former wood storage building. The highest subsurface soil detection of dioxin was next to former wood storage building area in sample SB-010 (4-10 feet) at a concentration of 3,700J ng/kg. A lesser concentration of 250J mg/kg was detected in a deeper sample at the same location, SB-010 (4-10 feet). Elevated concentrations of dioxin were also detected in shallow and deeper subsurface soil samples from Process area samples SB-001 and SB-002, located near the CCA and PCP drip pads, ranging from 550J to 660J mg/kg.

1.4.3 Ground Water

Ground water at the Site is impacted primarily by arsenic and PCP. The arsenic plume is contained within the PCP plume in the overburden.

Figure 1.4-1 depicts the distribution of PCP in overburden ground water at the Site. The highest concentration of PCP detected in overburden ground water was in piezometer PZ-007 at a concentration of 17,000 ug/L. PZ-007 is located at the edge of the former wood treatment building paved area. The highest concentration of arsenic was in piezometer MW-003 at a concentration of 940 ug/L, exceeding the ground water screening criteria of 10 ug/L. MW-003 is located at the edge of the PCP drip pad in the Proces area. Based on the southwesterly direction of ground water flow and the absence of detectable PCP in piezometer PZ-004, it appears that the extent of contamination in overburden ground water is bounded by the Rumford River and the backwash channel.

Figure 1.4-2 shows the extent of PCP in bedrock ground water. The highest concentration of PCP was detected in well MW-101R coincident with the location of the highest concentration of PCP detected in the overburden. Similar to PCP, the highest concentration of arsenic was detected in MW-101R at 37 ug/L. Elevated arsenic concentrations were also detected in downgradient monitoring wells MW-105R, MW-008B, and MW-009B at 8.8, 10.6, and 9.2 ug/L, respectively. Based on the absence of detectable PCP and low concentrations of arsenic in wells MW-107R and MW-109R, which are located across the Rumford River, it appears that the plume is confined to the Site, bounded by the River channel and that there are no off-site impacts to bedrock ground water.

1.4.4 LNAPL

LNAPL, ranging from a sheen to several inches, was observed in overburden wells, primarily in the SE/SW Quadrant. The greatest accumulation of LNAPL, 0.91 foot (approximately 11 inches), was observed in well MW-012. LNAPL was not observed in bedrock monitoring wells. No. 6 fuel oil, SVOCs, metals, and dioxin were detected within the LNAPL.

LNAPL free product is largely confined to the monitoring wells in the SE/SW Quadrant of the Site (south of the railroad tracks), but was also detected in one monitoring well north of the railroad tracks. Isolated pockets of free product and LNAPL-saturated subsurface soils were detected throughout the Site ("oily soil" spots); additional soil sampling and excavation during Remedial Design will reveal the exact locations.

1.4.5 Surface Water

PCP and two PAHs [benzo(a)anthracene and benzo(a)pyrene] were detected above surface water screening criteria in on-site Rumford River surface water samples. The highest concentration of PCP in surface water was detected in on-site vernal pool sample VP-002 at 680 ug/L, which exceeds the screening criterion of 15 ug/L. Elevated concentrations of PCP were detected along the Rumford River from the abandoned ground water treatment system to just beyond the backwash channel.

1.4.6 Sediment

PAHs including naphthalene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene were detected in upstream sediment samples at concentrations exceeding sediment screening criteria. In general, the highest concentrations of PAHs in upstream samples were detected at location SD-018, located downstream of Glue Factory Pond.

The same PAHs detected in upstream sediment were detected in on-site sediment samples at concentrations exceeding sediment screening criteria. In general, the highest concentrations of PAHs were detected at location SD-013, located in an upgradient area of the Site. Other SVOCs detected above sediment screening levels are 2-methylphenol, dibenzofuran, diethyl phthalate, and PCP.

The highest concentration of PCP in sediment was detected in on-site vernal pool sample VP-002 at 690 mg/kg, which exceeds the screening criterion of 0.36 mg/kg. PCP detected in on-site sediment samples from the Rumford River ranges from non detect (ND) to 51 mg/kg. The highest concentration, 51 mg/kg, was detected at SD-009 located near the ground water treatment system. PCP in downstream sediment samples range from ND to 0.55 mg/kg at SD-024.

The highest concentrations of dioxin were detected in on-site Rumford River sediment located downstream of the Process Area between the railroad tracks and the ground water treatment system. Detected concentrations of dioxin exceed the sediment screening criterion of 410 ng/kg at three locations in this reach: RRHP02 (2,273J ng/kg), RRHP03-S (1,017J ng/kg), and SD-009 (1,200J ng/kg). Dioxin in downstream sediment samples range from ND to 200J ng/kg at SD-024.

1.4.7 Fish Tissue

Fish tissue in the Rumford River was examined. Contaminant concentrations in on-site samples were generally higher than samples taken upstream of the Site. Concentrations of pentachlorophenol and dioxin were higher in on-site samples than upstream samples, while concentrations of metals (arsenic, cadmium, chromium, copper, and lead) were similar in on-site samples to upstream samples. See 4.6 of the R.I. Report for more information.

1.5 Risk Assessment

1.5.1 Human Health Risk Assessment

Table 1.5-1 shows a summary of the baseline Human Health Risk Assessment ("HHRA"; M&E, 2005) conducted for the Site. The risk assessment evaluated current and potential future human health risks associated with contaminants of potential concern (COPCs) detected in the following media[3]:

- On-site soils (surface and subsurface)
    - Process area
    - SE/SW quadrants
    - North of fencing along County Street ("County Street")
- On-site sediment and surface water
    - Rumford River and associated wetlands
- Off-site sediment and surface water
    - Rumford River
    - Fulton and Kingman Ponds
- Fish Tissue Ingestion
    - Fulton Pond
    - Kingman Pond
    - Glue Factory Pond
- Ground water
    - Overburden and Bedrock aquifer
    - Indoor air inhalation

Potential noncarcinogenic (Hazard Indices or "HI") and carcinogenic (Increased Lifetime Cancer Risk, or "ILCR") human health risks were calculated for various scenarios of exposure to each medium (soil, ground water, sediment, surface water, etc.). Multiple exposure pathways (such as ingestion, dermal contact, and/or indoor air inhalation) were quantitatively evaluated for each

[3] **COPCs for the Site soils include benzo(a)pyrene, arsenic, chromium, dioxin, and pentachlorophenol (PCP). In ground water the COPCs include PCP, arsenic, dioxin, PAHs, vinyl chloride, trichloroethene, chromium, manganese, and trichlorophenol.**

scenario (for example, resident or commercial worker). The central tendency (CT) and reasonably maximum exposure (RME) cases were determined for each pathway. Detailed information about the assumptions underlying each exposure scenario and the calculations of risk for each pathway can be found in the Human Health Risk Assessment (M&E, 2005) and the attached memorandum addressing the recreational use of the SE/SW quadrant (Appendix E).

Exposure pathways were evaluated for the following scenarios:

- Current and future trespasser (surface and subsurface soils, surface water, sediment)
- Current and future off-site resident (ground water, surface soil, surface water, sediment)
- Future on-site resident (surface and subsurface soils, indoor air, surface water, sediment)[4]
- Future Town Worker (Surface and subsurface soil)
- Future Commercial Worker (surface and subsurface soil, indoor air)
- Future utility worker (surface and subsurface soil, overburden shallow ground water)
- Recreational user (fish tissue ingestion, surface water, sediment)

When risks were estimated for a young child and adult receptor (i.e., residents and recreational users), the young child noncarcinogenic risks (HIs) were presented as the most conservative, while carcinogenic risks (ILCRs) presented represent the sum of the young child and adult risks (i.e., a total receptor risk). Medium-specific risks and hazards, as appropriate, have been summed together for receptors that are assumed to be exposed to more than one medium during Site-related activities. HIs, segregated by systemic effects, are presented. In cases where the total receptor HI exceeded 1, only COPCs having similar systemic effects were summed for each pathway and medium.

EPA determined that the increased lifetime cancer risk from a Site should generally not exceed 10^{-4} (See 55 Fed. Reg. 8717, 1990).[5] An ILCR of 10^{-6} is the "point of departure" when determining the extent of cleanup under CERCLA, and decision-makers may design cleanups to achieve an ILCR anywhere within the range of 10^{-6} to 10^{-4} for a given contaminant or medium depending on other factors, such as cumulative exposure from multiple contaminants or pathways, uncertainty, or likely future use of the Site. (See 40 C.F.R. 300.430(e)(2) and Preamble to the National Oil and Hazardous Substances Contingency Plan, "NCP", at 55 Fed. Reg. 8715-19, 1990)

The evaluation of these scenarios showed that some exposure pathways resulted in increased lifetime cancer risk (ILCR) or hazard index (HI) outside of EPA's acceptable risk range, while some pathways resulted in a HI less than 1 and an ILCR within the EPA's target risk range of 10^{-4} to 10^{-6}. Some pathways were incomplete or the risk was indeterminate (see below).

Exposure Scenarios Exceeding EPA's Target Risk Range

The following pathways, which resulted in an ILCR greater than 10^{-4} (posing an unacceptable risk) are listed in Table 1.5.1. A risk outside EPA's target range provides a basis for remedial action under CERCLA.

[4] For Foxborough parcel consisting of 1.77 acres.

[5] An ILCR of 10^{-4} means an additional one-in-ten thousand risk of developing cancer over an individual's lifetime. 10^{-5} means a one-in-one hundred thousand risk, and 10^{-6} means a one-in-one million risk.

- Process Area
    - *Surface Soil* – for each of the following exposure scenarios, *ingestion and dermal contact* with *soil* were found to create a risk outside EPA's target risk range[6].
        - Adolescent Trespasser (current and future)
        - On-site resident (future)
        - Town worker (future)
        - Commercial worker (future)
        - Utility worker (future)
    - *Sub-Surface Soil*[7] –For each of the following scenarios, *ingestion* and *dermal contact* with *sub-surface soil* were found to create a risk outside EPA's target risk range:
        - On-site Resident (future)
        - Commercial worker (future)

- On-site Ground water (contaminant plume)[8]
    - *Bedrock* – Off-site Resident – Drinking water and dermal contact (future)
    - *Overburden (shallow)* – Off-site Resident -- Drinking water and dermal contact (future)
    - *Overburden (shallow)* **–** Off-site Resident – Swimming Pool (future)

<u>Exposure Scenarios Within EPA's Target Risk Range:</u>

The following scenarios resulted in risks in the range of 10^{-5} to 10^{-6} or below.

- Process Area
    - *Sub-surface soil*
        - Town worker (future)
        - Trespasser (future)
        - Utility Worker (future)
- SE/SW Quadrant
    - *Surface Soil*
        - On-site Resident (future)
        - Adolescent Trespasser (current and future)
        - Commercial Worker (future)
    - *Sub-Surface Soil*
        - Adolescent Trespasser (future)

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6 The *surface water* (ingestion and dermal contact) pathways and the *indoor air* inhalation pathway were also evaluated for the Process Area and neither resulted in an actionable risk.

7 The sub-surface soil scenarios reflect future conditions, in which the soil currently located under the surface would be exposed.

8 These scenarios evaluate the use of the ground water currently located underneath the site. The scenarios conservatively assume that the contaminant plume will migrate to a location outside the current site boundary and will be used by off-site residents and be accessed via existing wells on their properties which are currently designated as non-potable. See further discussion of Incomplete Pathways, below.

- County Street
    - *Surface soil*
        - Utility Worker (future)
        - Resident (future)
        - Commercial worker (future)
    - *Sub-Surface Soil*
        - Utility Worker (future)
        - Resident (future)
        - Commercial worker (future)

- Fulton and Kingman Ponds, Glue Factory Pond
    - *Fish Tissue Ingestion*
        - Young Child/Adult Recreational User (current and future)

- Rumford River Downstream
    - Current/Future Young Child/Adult Resident (using the Rumford River for recreation)

- *Off-Site* Ground water
    - *Bedrock (deep)* - Off-site Resident – Swimming Pool scenario (current)[9]

- *On-Site* Ground water (contaminant plume)[10]
    - *Bedrock (deep)* – Off-site Resident – Swimming Pool scenario (future)

- Indoor Air
    - Future Commercial Worker
    - Future On-site Resident

<u>Incomplete Pathways and Indeterminate Risks</u>:

- *Ground water: Ingestion and Non-Potable Uses*– incomplete pathway

  Ground water use was considered in the risk assessment before Massachusetts had issued its use and value determination and before EPA was advised of the Town of Mansfield's Reasonably Anticipated Future Land Use for the Site.

- *Dermal Contact with Ground water and Surface Water* – indeterminate risk for some compounds

  For some scenarios, the exposure pathways of dermal contact with ground water and surface water were evaluated.[11] Risks as a result of dermal absorption cannot be quantified for all

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[9] Currently, non-potable Ground water wells are located on residential properties adjacent to the Site. These wells are considered to be "off-site." The RI found that these wells were not impacted by contaminants from the site.

[10] See Footnote 7, above.

contaminants. Data needed to predict dermal absorption is insufficient for some compounds. This uncertainty may result in an underestimate of risk.[12] Periodic reviews of the remedy for the Hatheway & Patterson Site will include review of the literature and EPA guidance to verify whether these models have been updated. If necessary, the remedy will be evaluated to address changed risk values.

The ILCR and HI shown for the dermal exposure pathways *do* include risks from *incidental ingestion* of the ground water or surface water and the risks from water *dermal exposure to other contaminants* for which a sufficient model does exist.

Lead

An evaluation of lead in soil and sediment indicates that exposures to lead, under both current and future conditions, do not result in blood levels in excess of the blood lead level goal for an adolescent trespasser, area resident, recreational user, County Street resident, on-site resident, commercial worker, or utility worker. In addition, the risk associated with lead in fish fillet tissue is consistent with that associated with fish tissue not impacted by the Site.

1.5.2 Ecological Risk Assessment

A screening level ecological risk assessment (SLERA) performed in 2003 using surface water and sediment analytical data indicated the presence of potential ecological risks to benthic invertebrates and fish in the Rumford River at the Site.

With respect to areas that are potentially vernal pools ("potential vernal pools") , the risk analysis in the SLERA was based on a single surface water and sediment sample collected from each of two potential vernal pools at the Site (specifically, VP-C2 and VP-D1). The first step consisted of developing a screening-level problem formulation to select COCs, and develop a conceptual site model (CSM) to describe exposure pathways, identify potential receptors of concern, and select assessment and measurement endpoints. The receptors of concern for the potential vernal pools included benthic invertebrates, water column invertebrates, and the aquatic life stages of amphibians (i.e., tadpoles). Fish were omitted because vernal pools have no permanent connection to the Rumford River and also dry out in the summer.

The SLERA was expanded to better quantify potential risk by calculating hazard quotients (HQs) for those COCs which exceeded their chronic surface water benchmarks and "no effect"

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[11] These included the Adolescent Trespasser scenarios (Process Area, SE/SW quadrants), Current/Future Young Child/Adult Resident Scenarios (Rumford River downstream, Shallow Ground water, Deep Ground water, SE/SW Quadrants, Process Area), Current/Future Recreational User (Fulton and Kingman Ponds), Future Utility Worker (Process Area Ground water, SE/SW quadrants Ground water), Off-site resident Ground water use.

[12] The contaminants found at the site for which no quantitative evaluation of the water dermal pathway was included in the HHRA include pentachlorophenol, dioxins, benzo(a)anthracene, benzo(a)pyrene, benzo(b) fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and phenanthrene. See Human Health Risk Assessment at 3.2.1., page 30, for further explanation.

sediment benchmarks. The evidence indicated that the potential for surface water risk was present in both potential vernal pools based on high levels of metals, and in VP-C2 based on high levels of PCP (HQ = 45.3). It was noted that the metals with the highest HQs (specifically, aluminum, iron, and mercury) were not associated with past activities at the Site and might therefore represent background conditions.

The analysis showed that potential risk for metals in sediment was present in VP-D1, but only when evaluated using the "no effect" benchmarks. This potential risk became insignificant when evaluated using the "effect" benchmarks (i.e., all "effect" HQs < 1.0). Metals were not associated with risk in VP-C2 sediment. This evidence suggested that metals (at least those with benchmarks) were not risk drivers in vernal pool substrates.

All SVOCs exceeded their "no effect" sediment benchmarks in VP-D1. The potential risk from SVOCs (with the exception of PCP with a "no effect" HQ = 2.2, but for which an "effect" benchmark was not available) became insignificant when evaluated using "effect" benchmarks (i.e., all "effect" HQs < 1.0).

All SVOCs also exceeded their "no effect" sediment benchmarks in VP-C2. The potential risk from SVOCs, with the exception of PCP ("no effect" HQ = 1,920, but for which an "effect" benchmark was not available), fluorene ("effect" HQ = 1.8), and 2-methylnaphthalene ("effect" HQ = 3.6), became insignificant when evaluated using "effect" benchmarks (i.e., HQs < 1.0). PCP was by far the biggest risk driver in VP-C2. With such a high HQ, it is reasonable to expect toxicity in the sediment from VP-C2.

The conceptual site model developed for the SLERA was expanded to identify all the likely exposure pathways and receptors associated with surface water and sediments in the Rumford River. The receptor groups of concern included benthic macroinvertebrates, water column invertebrates, fish, piscivorous birds, and piscivorous mammals. Exposure routes included direct exposure to surface water or sediments for invertebrates and fish, and ingestion of surface water, sediments and aquatic biota for piscivorous wildlife. EPA decided to proceed with a baseline ecological risk assessment (BERA) to better quantify the extent of these hypothetical risks.

A BERA was performed in 2004 for the Rumford River at the Site. The BERA concluded that no significant risk is expected for benthic macroinvertebrates, water column invertebrates, fish, piscivorous birds, and piscivorous mammals.

The potential vernal pools showed apparent signs of impairment. Ambystomid salamander egg masses, spermatophores, or individuals (particularly yellow spotted salamanders which are common in Massachusetts), all which would be expected to be present given the extensive forest community surrounding the vernal pools, were not observed at any point during the survey. Further study will be conducted during remedial design to determine if contamination in sediment and/or surface water poses a risk to these areas and whether threatened or endangered species or habitat are impacted

2.0 REMEDIATION OBJECTIVES AND APPROACH

The overall FS objective is to develop cost-effective remedial alternatives that will be protective of public health and the environment. The developed alternatives must achieve compliance with the applicable or relevant and appropriate requirements (ARARs) and maintain long-term effectiveness through reduction in contaminant toxicity, mobility, and volume. A complete discussion of ARARs is presented in Section 5. The remedial goals established in this section for the Site would be accomplished through (1) reduction in source volume, (2) reduction in off-site migration potential, and/or (3) reduction in potential exposures.

All major sources of risk and exposure pathways identified in the Human Health Risk Assessment, or 'HHRA' (M&E, January 2005) were reviewed to develop remedial alternatives. No current or future risk to ecological receptors was found in the Baseline Ecological Risk Assessment , or 'BERA' (US EPA, March 2005), although further study will be conducted prior to remedial design with regard to certain potential vernal pools on the Site in accordance with the Screening Level Environmental Risk Assessment for Vernal Pools, or 'SLERA' (US EPA, March 2005).

Site risks will be managed through a combination of initiatives such as: source reduction, treatment, engineering and institutional controls, as well as monitoring with ground water wells that would provide advance information about potential off-site migration. Table 1.5.1 displays the projected residual risk for each contaminant after a Site remedy is completed.

The purpose of the FS is to develop a range of remedial alternatives to achieve the remedial objectives for the Site. The alternatives development process consists of the following general steps.

- Develop remedial action objectives for contaminated media and source material that permit a range of treatment and containment alternatives. The development of remedial action objectives is based upon contaminant-specific ARARs and risk-based cleanup criteria.

- Identify general response actions that would achieve the remedial action objectives for the contaminated media and source material. A general response action is the broadest classification of the remedial action and includes such groupings as treatment, disposal, and containment.

- Identify the extent of contaminated media and source material to which general response actions might need to be applied. Identify volumes of media that require remediation with consideration given to the requirements for protectiveness, as identified by the remedial action objectives, and the chemical and physical characteristics of the Site.

- Identify technology categories that may feasibly achieve the goal of each general response action. This process, referred to as "initial screening," serves to identify potentially applicable technologies and to eliminate technologies that are clearly not implementable at the Site or would not be effective in treating Site contamination.

- Identify and evaluate technology options to retain a representative process for each technology category for further consideration. This process is intended to represent the broader range of process options within a general technology type and represents secondary screening of technologies. If possible, a single process option is selected to be representative of the potentially applicable process options identified for each general response action.

- Assemble the preferred technology options into alternatives that represent the range of general response actions.

- Following development of the alternatives, screen each alternative based on cost, effectiveness, and implementability. The objective of this screening is to reduce the number of alternatives that would undergo detailed evaluation by eliminating less preferable alternatives.

2.1 Remedial Action Objective (RAO) Development

2.1.1 Remedial Action Objectives

Remedial Action Objectives (RAOs) were developed for various media at the Site to be protective of human health and the environment based on the results of the Remedial Investigation and Risk Assessments. The RAOs identify the media, COPCs, exposure routes, receptors and preliminary remediation goals for each exposure route.

General Remediation Objectives

General remedial action objectives are defined by the NCP and CERCLA, and apply to all Superfund sites. Whereas CERCLA goals relate to statutory requirements for development of the remedy, site-specific goals relate to the site-specific conditions, contaminated media, potential exposure routes, and identified target remediation levels. Site-specific goals require an understanding of the contaminants in the media and are based upon an evaluation of the risks to human health and the environment associated with the Site contaminants as previously discussed.

The statutory scope of CERCLA includes the following general goals for remedial actions at CERCLA sites.

- Refinement of the objectives for the degree of remedial action cleanup in that remedial actions "shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further releases at a minimum which assures protection of human health and the environment" [Section 121(d)].

- Preference for the selection of remedial actions "in which treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element" [Section 121(b)]. An explanation must be provided if a permanent solution using treatment or recovery technologies is not selected.

- Requirements that the selected remedy comply with or attain the level of any "standard, requirement, criteria, or limitation under any Federal environmental law...or any promulgated standard, requirement, criteria, or limitation under State environmental or facility siting law that is more stringent than any Federal standard, requirement, criteria, or limitation" [Section 121(d)(2)(A)].

Because of the potential hazards at the Hatheway & Patterson Site associated with contaminated media, Site-specific remedial action objectives were developed to comply with these requirements.

Site-Specific Remedial Action Objectives

Remedial action objectives were developed to meet ARARs and to address human health and ecological risks posed by exposure to Site contaminants. Based on the risk assessments and the reasonably anticipated future uses of the Site, remedial action was found to be appropriate for the following media and receptors:

Residential Exposure Scenario (Foxborough Parcel Only)

- Surface soil in the process area .
- Subsurface Soil in the process area
- Ground water (shallow and bedrock aquifer)[13]

Commercial/Open Space Exposure Scenario

- Surface soil in the process area.
- Subsurface Soil in the process area.
- Ground water (shallow and bedrock aquifer)[14]

Vernal Pools

- Further study will be conducted to determine whether surface water or sediment in potential vernal pools pose an actionable risk to ecological receptors.

The RAOs for the Site set forth **specific remediation goals that will** reduce the unacceptable risks identified in the baseline risk assessments and meet risk-based chemical specific standards which are likely to be exceeded if no action is taken. RAOs are limited to media, geographic areas, and chemicals for which estimated risk exceeds EPA target risk ranges or chemical-specific standards.[15]

RAOs for the Hatheway & Patterson Site are listed below.

- Surface Soil (Process Area) – Prevent current and future trespassers and future on-site residents (Foxborough parcel), commercial workers, town workers, and utility workers from ingestion or dermal contact with COPCs (including arsenic, dioxin, and

[13] Ground water is considered to be an incomplete pathway, see Footnote 4.
[14] See above footnote.
[15] See Table 1.5.1., 1.5.2 and Human Health Risk Assessment, and Vernal Pool Risk Assessment.

pentachlorophenol) which would result in a cumulative excess cancer risk greater than 10^{-4} to 10^{-6} or HI =1.

- Subsurface Soil (Process Area) – Prevent future commercial workers and future on-site residents (Foxborough parcel) from ingestion or dermal contact with COPCs (including arsenic, dioxin, and pentachlorophenol) which would result in a cumulative risk greater than 10^{-4} or HI=1.

- Sediment – (If further study determines that contamination in sediment poses a risk to vernal pools which is outside EPA's target risk range for ecological receptors): Prevent ecological receptors from exposure to unacceptable risk from COPCs in vernal pool sediment and surface water, to the extent feasible.

- Ground Water – Prevent discharge of pentachlorophenol and other COPCs to surface water at concentrations that would result in an instream exceedance of the Ambient Water Quality Criteria (AWQCs) through source control. Prevent exposure to ground water by future residents, recreational users, or commercial workers by monitoring extent of plume (to ensure it is remaining on-site) and implementing institutional controls to restrict ground water use within the Site boundary.[16]

- Inter-Media Transfer - Eliminate or reduce potential for leaching and inter-media transfer of COPCs from soil to ground water and surface water.

- LNAPL (Free Product) – Prevent further contaminant transfer from LNAPL source material to ground water by reducing LNAPL source material in soil excavation/treatment areas. Prevent further migration of LNAPL free product to ground water and surface water by removing free product "hotspots" to the extent feasible.

2.1.2 General Response Actions

General response actions are those remedial actions that will satisfy the RAO requirements. General response actions for the contaminated media at the Site were formulated based on the results of the Remedial Investigation and the Human Health and Ecological Risk Assessments.

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[16] EPA guidance provides that remedial action objectives for Ground water aquifers classified as "low" use and value should generally address migration of source material, protection of ecological receptors, and protection of other beneficial uses, while taking into account site-specific conditions. See *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites* at 5.4.2 (Ground Water That Is Not Current or Potential Drinking Water) (EPA, Dec. 1988) (OSWER Dir. 9283.1-2) (emphasis added). Region I guidance provides that RAO's for low use and value aquifers should generally include "prevention of exposure to contaminated ground water and prevention of further migration, but generally will not include a goal of restoration." *Ground water Use and Value Determination Guidance: A Resource-Based Approach to Decision Making*, at 9 (EPA Region 1, April 1996) (emphasis added). *Available at* http://www.epa.gov/region1/superfund/resource/gwater.pdf.

Ancillary remedial activities (such as wetland restoration, backfilling, etc.) are considered part of the remedial actions listed below. These additional remedial activities are identified and evaluated in the alternative development, initial screening and detailed analysis sections that follow.

A brief description of the general response actions is provided below.

No Action

The No Action general response action will be considered throughout each phase of the FS as required by the NCP. It involves no actions to limit future exposures to human health and/or the environment. While monitoring could be included, no institutional controls would be conducted as part of a No Action alternative. The Site would remain in its present condition, which reflects two completed CERCLA removal actions.

Limited Action – Institutional Controls

Institutional controls involve steps that could be taken to limit the potential for exposure to contaminated media. Institutional controls for the Site would include limiting potential future Site uses (i.e., land use restrictions) and limiting Site access (e.g., fencing). Institutional controls are typically implemented in conjunction with other remedial components and monitoring, but could also act as the sole remedial action at a site.

Containment

Containment involves the consolidation and physical isolation of contaminated media. The most apparent containment technology for Site soil would include capping which could isolate or immobilize contaminated soil with or without treatment, thereby limiting the potential exposure to, and mobility of, contaminants.

Excavation

Physical excavation of contaminated soil and sediment by conventional techniques is implemented in conjunction with other remedial components.

The type of equipment used for excavation depends on proposed excavation volume(s) and depth(s). Contaminated soils and, if necessary, sediments for the Site could be excavated with conventional construction equipment such as backhoes, excavators, front-end loaders, etc. As contaminated materials are excavated, they could be transferred to trucks or a temporary storage area, preferably a diked or bermed area lined with plastic or low-permeability clay. If excavation of saturated zone soils is necessary, dewatering can be performed by the use of pumps to lower the water table to facilitate removal activities, or the excavation can be performed without dewatering (“in the wet”). Excavation of saturated soils would require the construction of dewatering pads to allow the soils to drain prior to further remedial activities. The water would be collected and treated on-site prior to discharge to the Rumford River or collected and taken off-site to a licensed disposal facility.

In-Situ Treatment

In-situ treatment may be used to reduce contaminant concentrations without the removal or containment of contaminated soil. In-situ treatment technologies that may be considered for the Site include numerous physical, chemical and biological treatment options. Examples include soil washing, physical separation, solidification/stabilization, chemical extraction and oxidation/reduction.

Ex-Situ Treatment

Ex-situ treatment technologies may be employed following removal of contaminated media. Treatment technologies include physical/chemical and biological treatment, as well as thermal treatment technologies. Treated soils and sediments may be disposed of on land after treatment to meet disposal criteria (including reuse as on-site backfill).

Disposal

In general, disposal is the placement of material following removal into an on-site or off-site structure or facility in order to isolate contaminants from human and ecological receptors to prevent adverse health or environmental effects. Depending on the type of on-site disposal, the excavated material may undergo an initial treatment. Off-site disposal options vary depending on the chemical characteristics of the excavated material in determining whether the material can be sent to a licensed RCRA C or D facility.

2.2 Preliminary Remediation Goals (PRGs)

Preliminary Remediation Goals (PRGs) are compound-specific and site-specific standards established to be protective of human health and the environment consistent with the established RAOs. The PRGs for all media were developed based on the following:

- Non-carcinogenic risk set at an HI of 1
- Excess Lifetime Cancer Risk (ELCR) factors of 10^{-5}
- ARARs and EPA Guidance
- Background concentrations

PRGs are used in the FS process to develop and evaluate remedial alternatives. Because PRGs are based on the results of the HHRA, PRGs were only developed for those compounds contributing to current or future risk at the Site. PRGs were chosen which corresponded with an excess cancer risk of 10-5 for each contaminant so that the cumulative cancer risk to each receptor from multiple contaminants and pathways would not exceed 10-4, the upper bound of EPA's target human health risk range.

Figure 2.2-1 shows the Reasonably Anticipated Future Uses (RAFU) of the Site.. This information was used to develop PRGs for various areas of the Site.

The RAFU in Foxborough was based on zoning in the small area of the Site within that community. The Town of Foxborough zoning allows for low density residential uses, therefore a residential PRG was utilized in this area of the Site.

The Town of Mansfield (owner of the remainder of the Site) has written to EPA indicating its expectations for the RAFU for the Site. There is a high likelihood that a commercial reuse of the section of the Site north of the railroad tracks will be pursued. The reuse of the Site to the south of the railroad tracks will most likely be either commercial or 'open space' whichever corresponds to a higher standard of cleanup, according to the correspondence received from the Town of Mansfield; therefore, a commercial/recreational PRG was used for the Mansfield portion of the Site. Appropriate deed restriction will be placed on the property in accordance with the RAFU.

The following sections present tables of the PRGs for impacted media at the Site. Each table contains a listing of the contaminant, the PRG and the basis (i.e., MCL, EPA policy, exceedance of hazard index of 1, or excess cancer risk of 10^{-5}) and the Reasonably Anticipated Future Use (RAFU) for each of the areas to be addressed.

2.2.1 Soil PRGs

Table 2.2-1 shows the soil PRGs for the RAFUs described above.

2.2.2 Sediment PRGs

There are no PRGs for the commercial/open space scenarios. This is because sediment was not found to pose an actionable human health risk under the NCP for these exposure scenarios; the current and future risk to human receptors from sediment was found to be within EPA's target risk range. If results of further vernal pool study indicate an actionable risk to ecological receptors, sediment PRGs will be developed as necessary to protect these receptors.

2.2.3 Ground Water PRGs

Table 2.2-2 lists the ground water PRGs. The ground water PRGs shown are based on protection of surface water bodies impacted by ground water discharge (calculations in Appendix F). PRGs were calculated based on the ground water concentration that would not cause surface water contamination in excess of the AWQCs after dilution by a representative estimated low-flow in the Rumford River.

2.3 Volume of Media Requiring Remediation

Figures 2.3-1, 2.3-2 and 2.3-3 show the locations and approximate areas of surface soil, shallow subsurface soil (1 ft to 4 ft), and deep subsurface soil (4 ft to10 ft), respectively, potentially requiring remediation based on the PRGs in Tables 2.3-1 and 2.3-2. The highlighted areas represent portions of the Site where PRGs are exceeded based on sample data and operation history. The areas are delineated based on contamination type (e.g., organic, inorganic, or mixed).

Table 2.4-1 presents a listing of estimated volumes of contaminated soil to be addressed for the exposure scenario selected based on the reasonably anticipated future use (RAFU).

Figures 1.4-1 and 1.4-2 show the extent of contamination in ground water for both overburden and bedrock. These maps are representative of the areas that are impacted by contaminants in excess of Site PRGs.

3.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

3.1 Introduction

Remedial alternative development requires the assembly of combinations of technologies and the media to which they would be applied into alternatives that address contamination on a site-wide basis. Prior to alternative development, general response actions that satisfy remedial action objectives and the potential technologies that are applicable to each general response action must be identified. Technologies and specific technology process options are then screened to allow the identification of technologies and representative process options that are combined to form remedial alternatives.

3.2 Initial Identification and Screening of Technologies

Table 3.2-1 presents the identification and initial screening of process option associated with the general response actions. The technology screening was performed as set forth in the RI/FS Guidance, with technologies screened on the basis of technical implementability.

The following databases, web sites and publications were researched to identify potential technologies for the Hatheway & Patterson Site.

- U.S. EPA Hazardous Waste Clean-up Information (CLU-IN) web site
- Federal Remediation Technologies Roundtable (FRTR) web site
- Remediation Technologies Network Remediation Information Management System
- Superfund Innovative Technology Evaluation (SITE) Program
- TSD Central
- Presumptive Remedy Guidance

According to EPA directive *Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites* (EPA, 1995) presumptive remedies for wood treater sites with soils, sediments, and sludges contaminated with organic contaminants are *bioremediation*, *thermal desorption*, and *incineration*. The presumptive remedy for wood treater sites with soils, sediments, and sludges contaminated with inorganic contaminants is *immobilization*.

Technologies considered for ground water were limited to no action or limited action (institutional controls and monitoring). No active ground water remediation technologies were considered in light of the State ground water Use and Value Determination referenced in Section 1.3 of this FS.

3.3 Process Option Evaluation

Table 3.3-1 presents an evaluation of process options that were identified as technically implementable in the initial screening. Upon identification of those technologies that are technically implementable at the Site, potential process options are further evaluated to allow the selection of a representative process option for each technology type. The process options are evaluated on the basis of effectiveness, implementability, and cost, described as follows:

Effectiveness: Each technology and/or process option was screened based on its ability to achieve the remedial action objectives relative to other process options within the same technology type. The following factors were considered:

(1) The potential for process options to accommodate estimated areas or volumes of media and meet the remediation goals identified in the RAOs;

(2) The potential impacts to human health and the environment during the construction and implementation of remedial activity; and

(3) The potential performance and reliability of the technology for remediating the media of concern under existing site conditions.

Implementability: This criterion addresses the technical and administrative feasibility of employing the technology and/or process option at the Site, including the following factors:

(1) Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology and the reliability of the technology;

(2) Administrative feasibility, coordination with other offices and agencies and the ability to obtain necessary permits for any off-site actions; and

(3) Availability of services and materials, including treatment, storage, and disposal services, and necessary equipment and skilled workers to employ the technology.

Cost: This criterion plays a limited role in this process option evaluation. At this stage, relative capital and operation and maintenance (O&M) costs are used to compare technology process options within the same technology type. Costs are then qualitatively evaluated based on engineering judgment as low, moderate or high.

4.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

This section discusses the development and screening of alternatives designed to mitigate the risks posed by the contaminants detailed in section 1.0 of this document and to meet the Remedial Action Objectives set forth in section 2.0. A range of technologies and process options were evaluated in Section 3.0, and the most appropriate technologies and process options were retained for further evaluation as remedial alternatives within the FS evaluation framework. This section assembles those technologies retained from Section 3.0 into potentially viable remedial alternatives to address the RAOs, and the initial screening of those alternatives in order to eliminate from the detailed analysis remedial alternatives that may not be technically effective, cost-effective, or implementable.

A series of Remedial Alternatives (RAs) were assembled to address the threats posed by contaminants within the soil and ground water and potentially in the sediment and surface water in the vernal pools. RAs were developed to provide a range of treatment and containment options for the affected media. The alternatives were assembled using the representative technologies surviving the screening process presented in Section 3.0 that appear to satisfy minimal requirements of effectiveness, implementability, and cost.

Table 4.0-1 shows a matrix of the potentially feasible technologies correlated with the assembled RAs. These alternatives represent combinations of technologies that would be able to approach or exceed ARARs.

Below is a summary of the selected components of the assembled RAs. Each of the individual process options within the assembled RAs meets these minimum requirements on a technology-specific basis. That is, the process options are capable of addressing the specific contaminants and impacted media at the Site.

The RAs were then evaluated against three criteria (effectiveness, implementability, and cost), in accordance with the EPA RI/FS guidance. These are the same criteria used for the process option screening in Section 3, and represent the minimum requirements for consideration.

Next, the assembled alternatives were evaluated from a Site-wide perspective, considering the interactions between different contaminants and media, logistical aspects relative to this specific Site, and overall implementation issues. The relative effectiveness, implementation, and cost of the RAs are evaluated individually in the following sub-sections.

4.1 Remedial Alternatives for Soil, Sediment, Surface Water, and LNAPL[17]

4.1.1 RA-S1 – No Action

This alternative requires that no further action be taken at the Site, including monitoring or the implementation of institutional controls. Any reduction in risk at the Site would be

[17] RAs for sediment and surface water are included in the event further studies during design indicate a risk in potential vernal pools.

accomplished through natural attenuation. Although this alternative does not accomplish any of the RAOs, it is retained as a baseline alternative for comparison in accordance with the NCP and the RI/FS Guidance.

4.1.2 RA-S2 – Limited Action

This alternative requires only the implementation of institutional controls (commonly enacted through deed restrictions or proprietary controls) at the property to mitigate risks due to dermal contact and incidental ingestion of soil and to prohibit use of ground water for potable uses. Land use restrictions may include health and safety requirements for any future subsurface work and restrictions on future use and redevelopment of the Site. This alternative also includes long term monitoring of ground water and surface water as well as Five Year Reviews. The monitoring program will include sampling to ensure that ground water contamination is not migrating to receptors off-site and that GW-2 and GW-3 uses are maintained.

4.1.3 RA-S3 – Thermal Desorption of Organics including PCP and LNAPL Soils, Off-Site Disposal of Dioxin, Stabilization of Metals Contaminated Soils and Consolidation of Contaminated Soils under Low Permeability Cover

Figure 4.1-1 shows a diagram of which areas will require remediation for this alternative.[18] Figure 4.1-2 shows a conceptual layout of how this alternative will be implemented. Figure 4.1-3 shows a diagram of the cover system that is anticipated.

The buildings in the process area will be demolished to allow the waste in place under them to be addressed. This alternative includes excavation and on-site treatment of certain contaminants through thermal desorption and/or stabilization. Treated soils and any other remaining contaminated soils, except as explained below, will be consolidated on-site under a low permeability cover.

Upon excavation, soils containing PCPs and SVOCs in excess of PRGs will be tested for leachability. These soils will also contain arsenic since these contaminants are co-located at much of the Site. If they fail, the soils will be subjected to a thermal treatment process which will minimize the presences of PCPs and SVOCs, leaving mostly arsenic. The condensate from the thermal process will be sent off-site to a licensed disposal facility. Should the remaining arsenic contaminated soil as well as any other arsenic contaminated soil fail a leachability test, it will be mixed with stabilization agent(s), for example Portland cement. Treatability design studies will be completed to arrive at a suitable mixture of stabilization agent(s) to ensure the protectiveness of the remedy. The stabilized soils will then be consolidated on-site under a low-permeability cover.

Soils containing dioxin at concentrations in excess of the PRG will be segregated and disposed of at an off-site licensed facility. Soils contaminated with LNAPL located south of the railroad tracks in an area considered to be an LNAPL hot spot will be excavated down to the water table. Any floating free product will be removed at the same time to the extent practicable through

[18] Figure 4.1-1 is used to illustrate RA-S3, RA-S4 and RA-S5. Additionally, the LNAPL remediation area is designed to comply with the LNAPL RAO in Section 2 of this FS.

some type of vacuum process and/or through the use of sorbent material. LNAPL soil may be dewatered and subjected to thermal desorption before disposal under the low permeability cover. Free product may be blended with the soil and subjected to thermal desorption. LNAPL contaminated soil outside the hot spot will be excavated to the extent it coexists with other Site contaminants targeted for excavation , treated similarly as that soil, and consolidated for disposal under the low permeability cover.

Excavated areas will be backfilled with clean soil. Affected wetlands will be restored. If further studies during design indicate a risk in the potential vernal pool areas, sediment may be excavated and consolidated under the low permeability cover and the vernal pool restored. If the pool is fed by contaminated ground water, it may be filled in and replicated elsewhere.

Current information indicates soil PRGs are exceeded on the boundary of the existing railroad right of way passing through the Site. Soil exposures within the area of the existing railroad right of way will be evaluated during design and appropriate action such as deed restrictions and fencing will be implemented if necessary.

Site water resulting from dewatering activities of soil (and potentially sediment) collected from contaminated areas will be discharged to the Rumford River after treatment in an on-site mobile treatment facility.

This alternative also includes long term monitoring of ground water and surface water, Five Year Reviews, and operation and maintenance of remedial components, including the low permeability cover. The monitoring program will include sampling to ensure that ground water contamination is not migrating to receptors off-site and that GW-2 and GW-3 uses are maintained.

Institutional controls would be included to prohibit use of Site ground water and to restrict residential land use except on the Foxborough parcel.

4.1.4 RA-S4 –Off-Site Dioxin and LNAPL Soil Disposal, Stabilization of remaining contaminated soils and Consolidation under Low Permeability Cover

Figure 4.1-1 shows a diagram of which areas will require remediation for this alternative. Figure 4.1-4 shows a conceptual layout of how this alternative will be implemented.

As with RA-S3, the buildings in the process area will be demolished to allow the waste in place under them to be addressed. Excavated soil and sediment would be replaced with clean backfill.

RA-S4 is very much like RA-S3 except there is no thermal treatment component in RA-S4. Instead, soils (and possibly sediment from potential vernal pools) containing PCPs, SVOCs, and arsenic would be excavated and tested for leachability. If they fail, they will be stabilized using a stabilization agent, for example Portland cement. As with RA-S3, treatability design studies will be completed to arrive at a suitable mixture of stabilization agent(s) to ensure the protectiveness of the remedy. The stabilized soils will then be consolidated on-site under a low-permeability cover.

Soils containing dioxin and LNAPLs will be disposed of off-site at a licensed facility.

Current information indicates soil PRGs are exceeded on the boundary of the existing railroad right of way passing through the Site. Soil exposures within the area of the existing railroad right of way will be evaluated during design and appropriate action such as deed restrictions and fencing will be implemented if necessary.

Site water from dewatering and wetland restoration activities will be handled as in RA-S3.

This alternative also includes long term monitoring of ground water and surface water, Five Year Reviews, and operation and maintenance of remedial components, including the low permeability cover. The monitoring program will include sampling to ensure that ground water contamination is not migrating to receptors off-site and that GW-2 and GW-3 uses are maintained.

Institutional controls would be included to prohibit use of Site ground water for potable uses and to restrict residential land use except on the Foxborough parcel.

4.1.5 RA-S5 – Excavation and Off-Site Disposal

Figure 4.1-1 shows a diagram of which areas will require remediation for this alternative.

This remedial alternative involves the extraction and off-site disposal of soil and, if necessary, sediment exceeding PRGs. Based on the relatively shallow depth of contamination, soil would be excavated using conventional excavation equipment (i.e., backhoe, excavator) and transported off site by dump trucks or rail cars. Contaminated soil may be stored on a geotechnical barrier on-site for a short-period of time during excavation before being shipped off-site. Material will not be stockpiled at the Site.

As with RA-S3 and RA-S4, the buildings in the process area will be demolished to allow the waste in place under them to be addressed. Excavated soil and sediment would be replaced with clean backfill.

Soils containing LNAPL will be removed under this alternative via excavation and disposed off Site. Dewatering activities may occur before off-site disposal, with water treatment prior to discharge to the Rumford River. Free product would most likely be containerized before off-site disposal. Soils contaminated with dioxin above Site PRGs will also be disposed of off-site.

Current information indicates soil PRGs are exceeded on the boundary of the existing railroad right of way passing through the Site. Soil exposures within the area of the existing railroad right of way will be evaluated during design and appropriate action such as deed restrictions and fencing will be implemented if necessary.

Restoration activities as well as long-term monitoring and institutional controls would be the same as RA-S3 and RA-S4.

4.2 Remedial Action Alternatives for Ground Water

The following two remedial alternatives were developed as additive alternatives to RA-S1, RA-S2, RA-S3, RA-S4 or RA-S5 to address ground water containing contaminants in excess of PRGs.

4.2.1 RA-G1 –No Action

This alternative requires that no further action be taken at the Site, including monitoring or the implementation of institutional controls. Any reduction in risk at the Site would be accomplished through natural attenuation. Although this alternative does not accomplish any of the RAOs, it is retained as a baseline alternative for comparison in accordance with the NCP and the RI/FS Guidance.

4.2.2 RA-G2 – Limited Action

This alternative requires only the implementation of institutional controls (commonly enacted through deed restrictions) at the property to mitigate risks due to dermal contact of ground water, and prohibit use of Site ground water as drinking water. This alternative also includes long-term monitoring of ground water and Five Year Reviews. The ground water monitoring program will include sampling to ensure that contamination is not migrating to receptors off-site and that GW-2 and GS-3 uses are maintained.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 Introduction

This section presents a detailed evaluation of the alternatives described in Section 4.0. The purpose of this analysis is to evaluate how the alternatives meet CERCLA remedy selection requirements, provide a basis of comparison for the various alternatives, and assist in the selection of the overall Site remedy.

The detailed analysis was conducted in accordance with CERCLA Section 121, the NCP (USEPA, 1990 and 1993a), and USEPA RI/FS guidance (USEPA, 1988). The detailed analysis contains the following information.

- A detailed description of each candidate remedial alternative emphasizing the application of various component technologies.

- An evaluation of each alternative against the first seven of the nine evaluation criteria described in the NCP (USEPA, 1990 and 1993a).

The detailed description of technologies or processes used for each alternative includes, where appropriate, preliminary site layouts and a discussion of limitations, assumptions and uncertainties for each component. These descriptions are intended to provide a conceptual design of each alternative and are intended to be used for alternative-comparison and cost-estimation purposes only.

5.2 Evaluation Criteria

The NCP [40 CFR Section 300.430(e)(9)(iii)] identifies nine criteria for evaluation of remedial alternatives. These nine criteria are listed below

- Threshold Criteria
    - Overall protection of human health and the environment
    - Compliance with ARARs
- Primary Balancing Criteria
    - Long-term effectiveness and permanence
    - Reduction of toxicity, mobility or volume through treatment
    - Short-term effectiveness
    - Implementability
    - Cost
- Modifying Criteria
    - State acceptance
    - Community acceptance

Of the nine criteria listed above, the NCP requires that only the first seven be examined during the FS. The remaining criteria, state and community acceptance, will be considered by EPA later. State comments will be provided during the FS process and public comments will be solicited by EPA during the Record of Decision process.

5.3 Cost Estimation

Tables 5.3-1 , 5.3-2, 5.3-3, 5.3-4 and 5.3-5 present detailed cost estimates for each Remedial Alternative, prepared in accordance with *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (EPA 540-R-00-002, July 2000).* As directed in the referenced document, the

> "cost estimates are developed during the FS primarily for the purpose of comparing remedial alternatives during the remedy selection process, not for establishing project budgets…"

Furthermore, the target accuracy for the cost estimates in this report are –30%/+50%, per the above-referenced document. The reduced level of accuracy is due to several factors including additional information that might be generated during pre-design studies, changes to the selected remedy that are necessitated as a result of public comments, the modifications to the cost discounting approach, costs based on actual vendor quotes, changes in the availability of technologies and disposal facilities at the time of Remedial Action, and other factors. A more accurate Construction Cost Estimate, accurate to –10%/+15% will be developed during Remedial Design.

In order to estimate costs for each alternative, each cost estimate also includes an estimate of the schedule for each alternative. The time-frame estimates were based on published construction scheduling material, and professional judgment. Because there is uncertainty associated with the in-place material volumes that may be treated or removed and disposed of, the treatment times, and the future cost of vendor services, costs should be viewed as estimates and should be used for comparative purposes only. Assumptions may or may not remain valid during alternative implementation. For example, details associated with long-term monitoring, such as the number and location of monitoring wells and surface water sampling points, have not been agreed upon, and will be determined in the Long-Term Monitoring Plan (LTMP) to be completed as part of the alternative implementation. This FS provides assumptions regarding the scope of the LTMP for purposes of detailed analysis and cost estimation. These and other cost uncertainties are discussed in the individual cost subsections.

Each cost estimate includes a net present worth (NPW) analysis to evaluate expenditures that occur over different periods. The analysis discounts future costs to a present worth and allows the cost of remedial alternatives to be compared on an equal basis. Present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life (USEPA, 1988). Consistent with USEPA guidance, a discount rate of 7 percent was used to prepare the cost estimates (USEPA, 2000).

Each cost estimate includes the following items:

- A contingency to account for unforeseen project complexities such as adverse weather, the need for additional site characterization, and increased construction standby times at a percentage of direct capital costs;

- Engineering design and construction services at a percentage of direct capital costs; and

- Health and safety, legal, and administrative fees at a percentage of direct capital costs.

Costs are presented as a NPW value for the lifetime of the remedial action alternative based on the estimated clean-up time. For alternatives with an indefinite clean-up period, or if anticipated to require greater than 30 years, a 30-year NPW cost is presented. Present worth for a 30-year period is provided as recommended by CERCLA guidance (USEPA, 1988) because of the uncertainty of certain assumptions such as discount rate, inflation, and technology advancement for periods greater than 30 years. Cost summary tables are presented for each alternative and identify capital, operations and maintenance, and NPW costs.

5.4 Detailed Evaluation Results

The following remedial action alternatives (RAA) were developed for detailed analysis.

Soil Remedial Alternatives

RA-S1: No Action

RA-S2: Limited Action (Monitoring and Institutional Controls)

RA-S3 – Thermal Desorption of PCP, and LNAPL Soils, Stabilization of Arsenic, Consolidation of Contaminated Soils Under Low Permeability Cover, Off-site disposal of dioxin contaminated soils.

RA-S4 –Off-site Disposal of Dioxin and LNAPL Soils, Stabilization of Arsenic and Consolidation of Contaminated Soils Under Low Permeability Cover

RA-S5—Excavation and Off-Site Disposal

Ground Water Remedial Alternatives

RA-G1: No Action

RA-G2: Limited Action (Monitoring and Institutional Controls)

Tables 5.4-1 and 5.4-2 provide a summary of the detailed evaluation for the soil remedial alternatives and the ground water remedial alternatives, respectively. The evaluation addresses is six of the seven criteria described above and evaluates each of the above alternatives to the criteria. Table 5.4-3 summarizes the estimated costs for each alternative and Tables 5.4-4 through 5.4-8 present more detailed cost information for each alternative.

5.5 Identification of Significant ARARs

CERCLA governs the liability, cleanup, financial responsibility, and response for hazardous substances released into the environment. CERCLA requires that all remedial actions be consistent with the NCP. The NCP specifies procedures, techniques, materials, equipment, and methods to be employed in identifying, removing, or remedying releases of hazardous substances. In particular, the NCP specifies procedures for determining the appropriate type and extent of remedial action at a site in order to effectively mitigate and minimize damage to, and provide adequate protection of, public health, welfare, and the environment.

During the FS process, an analysis is made of legal and policy requirements that could affect the implementation of remedial alternatives. This analysis evaluates the compliance of each proposed remedial alternative with ARARs. Determination of ARARs is Site-specific and depends on the chemical contaminants, site/location characteristics, and remedial actions being investigated for site cleanup. Consideration of ARARs is undertaken to fulfill the requirements of CERCLA, the NCP, and other laws that must be addressed by the USEPA or parties undertaking the remedial action.

The national goal of remedy selection is to protect human health and the environment, to maintain that protection over time, and to minimize untreated waste (40 CFR Part 300.430 of the NCP (55 FR 8846)). In accordance with Section 121(d) of CERCLA, site remediation must comply with all applicable or relevant and appropriate laws, regulations, and standards promulgated by the federal government, except where waived. State requirements must also be attained, under Section 121(d)(2)(c), if they are legally enforceable and consistently enforced statewide, and if the state ARAR is more stringent than the federal ARAR and has been presented to the EPA in a timely manner. Statutory waiver conditions that may be used, if protection of human health and the environment is to be ensured, consist of the following.

- The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed.

- Compliance with such requirements is technically impracticable from an engineering perspective.

- Compliance with such requirement at that facility will result in greater risk to human health and the environment than alternative options.

- The remedial action selected will attain, through use of another method or approach, a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation.

- In the case of a remedial action to be undertaken solely under Section 104, selection of a remedial action that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration, and the availability of money from the fund to respond to other sites, taking into consideration the relative immediacy of such threats.

- With respect to a state standard, requirement, criteria, or limitation, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criteria, or limitation in similar circumstances at other remedial action sites within the state.

The NCP defines “applicable” and “relevant and appropriate” requirements. Applicable requirements consist of those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. In addition, other environmental and public health guidelines, although not ARARs, may be considered to help determine what is protective or to determine CERCLA remedies. These guidelines are termed “to be considered” (TBC).

CERCLA Section 121(e), codified at 40 CFR Part 300.400(e), exempts any response action conducted entirely on-site from having to obtain a federal, state, or local permit, where the action is carried out in compliance with Section 121. Remedial actions conducted on Superfund sites need comply only with the substantive aspects of ARARs and not with the corresponding administrative requirements.

Identification of potential ARARs to be considered for the Site and adjacent wetland areas are organized into three categories, following the EPA CERCLA Compliance with Other Laws Manual (Interim Final -- EPA/540/G-89/006, Part II -- EPA/540/G-89/009 guidance (U.S. EPA, 1988 and 1989):

- Chemical-specific
- Location-specific
- Action-specific

Each potential ARAR was reviewed to evaluate the potential applicability or relevancy and appropriateness according to the procedures identified in CERCLA Compliance with Other Laws Manual (OSWER Directive 9234.1-01), Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (OSWER Directive 9355.3-01), and RCRA, Superfund & EPCRA Hotline Training Module: Introduction to Applicable or Relevant and Appropriate Requirements (OSWER 9205.5-10A).

Table 5.5-1 lists the chemical-specific ARARs identified for the Site. Chemical-specific ARARs set health or risk-based concentration limits or limitations in environmental media for specific hazardous substances. These requirements are generally used to help set protective cleanup levels for chemicals of concern in designated media. If a chemical has more than one ARAR, the more stringent requirement is typically considered the ARAR.

Table 5.5-2 lists the location-specific ARARs identified for the Site. Location-specific ARARs restrict the concentrations of hazardous substances or the type of activities conducted at a site based on the site's location.

Table 5.5-3 lists the action-specific ARARs identified for each Remedial Alternative. Action-specific ARARs are those requirements associated with the remedial actions under consideration for the Site. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities related to management of hazardous substances. Action-specific ARARs are presented in Section 5 for each remedial alternative that is developed later in this report.

Each alternative was evaluated based on its potential to meet or exceed ARARs. Selected issues relating to compliance of the remedial alternatives with ARARs are discussed below.

Wetland, Floodplain, and Vernal Pool Regulations

The Hatheway & Patterson Site contains wetlands, parts of the Site are located within the 100-year floodplain, and the Site contains depressions which may meet the characteristics of vernal pools (as defined by the Commonwealth of Massachusetts). To comply with federal and state regulations relating to these hydrologic features, all active remedial alternatives (RA-S2, S3, S4, S5 and G2) will require choosing the least disruptive alternative which will best maintain or restore the benefits of the wetlands ecosystem. Excavation, treatment, monitoring wells, construction, or other activities will only be carried out in wetlands areas of the Site if there is no practicable alternative to doing so. Public participation requirements for remedial activities occurring in wetlands, vernal pools, and floodplains will be met through specific request for comment during the proposed plan on activities in the wetlands/floodplains.

As discussed above, further study must be carried out during the Remedial Design phase to determine whether the depressions on Site are certifiable or, at a minimum, characteristic of vernal pools and whether they serve as habitat to species of concern. If so, the substantive aspects of Massachusetts wetlands regulations relating to vernal pools will be met. If not, the depressions will be addressed identically to the surrounding soil or sediment. If vernal pools are certifiable or at a minimum characteristic of vernal pool habitat, and if RA-S3, S4, or S5 is chosen, remedial activities for the vernal pools may include excavating the contaminated sediment or filling the depression with clean backfill, depending on whether the source of the contamination is found to be from surface water or ground water. If disrupted, vernal pools will be replaced elsewhere on the Site.

RCRA Regulations

RCRA, the Resource Conservation and Recovery Act establishes a comprehensive scheme of regulation for the transportation, storage and disposal of hazardous waste. Although the Site was a wood treating facility, the contamination was not found to constitute "listed waste" based on the limited available information about past operations at the Site. Contaminated media at the Hatheway and Patterson Site may exhibit characteristics similar to RCRA "characteristic" waste. Therefore, certain requirements of RCRA must be met or considered during the remediation process and when determining the final condition of the Site.

RCRA regulations appear as either applicable or as relevant and appropriate requirements. For alternatives that generate hazardous waste during activities such as soil excavation, during thermal treatment or stabilization or during well drilling, RCRA is applicable. For activities that are not directly regulated by RCRA but are similar to such regulation activities RCRA requirements are relevant and appropriate. For example, alternatives that include excavating contaminated soil must comply with the substantive requirements of RCRA standards for generators of hazardous waste. On the other hand, alternatives that include consolidation of waste onsite within an Area of Contamination (AOC) do not trigger RCRA liner requirements that normally apply to landfills or waste piles. However, to eliminate risk from dermal contact with the soil, these alternatives include a low permeability cover similar to that used on hazardous waste landfills. Certain RCRA requirements for landfill closure and post closure care of covers and for groundwater monitoring were identified as relevant and appropriate.

Similarly, because some alternatives include waste consolidation onsite within an AOC, RCRA Land Disposal Regulations, which require minimum treatment standards, do not apply to the consolidated waste. To ensure that the waste under the low permeability cover does not leach into the groundwater and cause a violation of GW-2 or GW-3 standards, these alternatives include a treatment component to reduce and/or stabilize organic and inorganic contaminants.

RCRA requirements for containers, storage of hazardous waste, waste piles, air stripping, and other requirements which govern the manner in which remediation activities are carried out, will be identified and will be met if RA-S2, S3, S4, S5, or G2 are chosen. RA-S2 and G2 would only require consideration of RCRA insofar as contaminated media constituting "characteristic" hazardous waste are disturbed in the process of digging additional monitoring wells. However, all alternatives would be subject to the corrective action requirements of RCRA, the substantive portion of which requires that ground water monitoring be conducted to ensure that Site contaminated ground water is not migrating to off-site receptors. (See below for further discussion of ground water.)

Because the base RCRA program has been delegated to the Commonwealth of Massachusetts, the State RCRA requirements are shown in the ARARs tables. Several federal RCRA requirements are also included because the State has not yet promulgated similar provisions.

<u>Ground Water Regulations</u>

The federal Safe Drinking Water Act (SDWA) and state drinking water regulations establish maximum concentration levels ("MCLs") for certain contaminants in aquifers which are potential drinking water sources. These chemical-specific ground water concentration limits must be met in aquifers which are potential sources of drinking water. None of these limits apply to the Hatheway & Patterson Site because the ground water is not considered a current or potential future drinking water source. (Massachusetts DEP has issued a determination that the ground water at the Site is of "low use and value." See discussion in Section 1 of this FS). However, MCLs will be used a measure of performance of the Site remedial action. Ground water monitoring wells will be installed to ensure that the on-site ground water plume is not migrating to off-site receptors.

The ground water under the Site appears to discharge to surface water (the Rumford River). The ground water is classified as GW-2 and GW-3 by Massachusetts DEP, meaning that ground water must be remediated based on its effects on indoor air quality and surface water quality. Surface water quality regulations establish ambient water quality criteria (AWQCs) that protect the designated uses of the water body (the Rumford River). No AWQC's are exceeded in the River but the ground water is present at concentrations that exceed the PRG for PCP. Should the most contaminated portion of the ground water plume (especially LNAPL free product) migrate further downgradient in the future, it is possible that contaminants in ground water, after dilution, could cause exceedances of the AWQC for PCP in surface water.

Therefore, the source control remedial options S3, S4 and S5 have been designed to prevent inter-media transfer of contaminants from soil or free product to ground water to surface water which would cause exceedance of AWQCs in the Rumford River. S2 and G2 include monitoring of surface water and ground water which would detect exceedance of AWQCs, should the contaminant plume migrate.

Five year reviews will assess effectiveness of the remedial action in protecting surface water and ensuring off-site receptors are not impacted by Site ground water.

6.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

6.1 Introduction

Comparative analyses of alternatives for the Site are presented in the following subsections. The remedial alternatives that are the focus of the comparative analysis are listed below.

General Site Alternatives

- RA-S1: No Action
- RA-S2: Limited Action
- RA-S3: Thermal Desorption of Dioxin, PCP, and LNAPL Soils, Stabilization of Arsenic, Consolidation of Contaminated Soil Under Low Permeability Cover, Off-site disposal of dioxin contaminated soils.
- RA-S4: Off-Site Disposal of Dioxin and LNAPL, Stabilization of Arsenic, Consolidation Under Low Permeability Cover
- RA-S5: Excavation and Off-Site Disposal

Ground Water Alternatives

- RA-G1: No Action
- RA-G2: Limited Action

This section compares the soil Remedial Alternatives (RA-S1, RA-S2, RA-S3, RA-S4, RA-S5) separately from the ground water Remedial Alternatives (RA-G1, RA-G2) since the ground water Remedial Alternatives would be added to and combined with one of the soil Remedial Alternatives.

The purpose of the comparative analysis is to evaluate the relative performance of each alternative with respect to seven of the nine NCP evaluation criteria. The section is used to aid in the selection of a remedial alternative for the Hatheway & Patterson Superfund Site by evaluating the advantages and disadvantages of each alternative as compared to these NCP criteria.

6.2 Approach to the Comparative Analysis

The NCP outlines the approach for performing the comparative analysis of site remedial alternatives. The remedy proposed must reflect the scope and purpose of the actions being undertaken and how these actions relate to other remedial actions and the long-term response at the site. Identification of the preferred alternative and final remedy selection are based on an evaluation of the major tradeoffs among alternatives in terms of the nine evaluation criteria. The NCP categorizes the evaluation criteria into three groups: threshold, balancing, and modifying. Each criteria group is discussed in the following subsections.

Threshold Criteria: Overall protection of human health and the environment, and compliance with ARARs are the two threshold criteria. An alternative must meet both criteria to be eligible for selection as the preferred site remedy.

Primary Balancing Criteria: The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. These balancing criteria provide a preliminary assessment of the extent to which permanent solutions and treatment can be used practicably and in a cost-effective manner and emphasizes long-term effectiveness and reduction of toxicity, mobility, or volume through treatment.

Modifying Criteria: State and community acceptance are the final balancing criteria. Formal state-regulatory-agency comments will not be received until after the agencies have reviewed the FS report and the Proposed Plan. Community concerns will be factored in following the public comment period on the Proposed Plan.

6.3 Comparative Analysis

Table 6.3-1 shows a summary of the Comparative Analysis.

6.3.1 Overall Protection of Human Health and the Environment

Soil Alternatives

Alternative RA-S1, No Action, would be the least protective of human health and the environment because it would offer no protection to human health and the environment. Because no remedial action would be performed, soil and ground water exceeding Site-specific PRGs would remain at the Site. Therefore, potential future unacceptable exposure to human health and the environment would remain at the Site. In addition, LNAPL would remain unaddressed and continue to leach into ground water, and ultimately reach surface water via ground water seeps. Similarly, potential vernal pool sediment may be impacted if fed by contaminated ground water. Deed restrictions would not be in place to ensure appropriate land use nor would fencing be assured to prevent trespassers from contacting Site soils. As a result, this alternative would not meet the threshold criteria in the NCP.

All other soil remedial alternatives include deed restrictions as well as fencing and other necessary institutional controls to prevent inappropriate land use and to maintain GW 2 and 3 uses. These alternatives also include long-term monitoring of ground water to ensure GW-2 (protect indoor air from volatilized contaminants) and GW-3 (no degradation of surface water via ground water contamination) conditions.

Alternative RA-S2 relies entirely on institutional controls and long-term monitoring to protect human health and the environment from exposure to contaminated Site media. Without addressing contaminated soils and, if necessary, protection is dependent on continued maintenance and enforcement of these controls.

The alternatives RA-S3, RA-S4, and RA-S5 offer the greatest level of protection to human health and the environment. Each of these alternatives would either eliminate or substantially reduce exposure to impacted source materials exceeding Site-specific PRGs to varying degrees. In addition to institutional controls and long-term monitoring, these alternatives utilize off-site disposal (for all excavated contaminated media in RA-S5), together with either immobilization and/or treatment, consolidation and containment under a low permeability cover (for RA-S3 and RA-S4). Because RA-S5 removes the greatest amount of materials that pose an unacceptable risk through excavation and off-site disposal, it provides the highest degree of overall protection.

Ground Water Alternatives

Alternative RA-G1, No Action, would be the least protective of human health and the environment because it would offer no protection to human health and the environment. Ground water contamination in the aquifer, although not a drinking water source, could migrate to off-site receptors undetected without monitoring. In addition, intermedia transfer of contaminants from unaddressed soils could endanger the quality of surface water in the Rumford River. The absence of institutional controls may allow unrestricted access to shallow ground water by utility workers as well as inappropriate use of ground water.

By implementing institutional controls and long-term monitoring of ground water as in RA-G1, although ground water contamination remains onsite, human health is protected through deed restrictions preventing inappropriate use of ground water, GW-2 and GW-3 conditions are maintained, and ground water is monitored to ensure it does not migrate to off-site receptors.

6.3.2 Compliance with ARARs

Soil Alternatives

Alternatives RA-S1 and RA-S2 would not meet soil cleanup levels or ground water PRGs that are based on surface water AWQCs.

Alternatives RA-S3, RA-S4, RA-S5, would meet all chemical, location and action-specific ARARs. See section 5.3 for discussion of significant ARARS and Tables 5.6-1 through 5.10-1 for additional identification and discussion of ARARs for each soil alternative.

Ground Water Alternatives

Because ground water is not a drinking water source there are no chemical-specific ARARs in RA-G1. Similarly, without action, there are no location- or action-specific ARARs.

RA-G2 also has no chemical-specific ARARs since the aquifer is not a drinking water source; however, it will comply with location-specific and action-specific ARARs .

See section 5.3 for discussion of significant ARARS and Tables 5.10-1 through 5.11-1 for additional identification and discussion of ARARs for each ground water alternative.

6.3.3 Long-Term Effectiveness and Permanence

Soil Alternatives

Alternative RA-S1 does not provide any long-term effectiveness in that there is a high magnitude of risk left behind from Site soils and possibly sediment remaining unaddressed. RA-S2 affords very little long-term effectiveness and permanence for protecting human health from exposure to soil at the Site through various institutional controls, which unless maintained and enforced would not remain permanent.

Alternatives RA-S3, RA-S4, and RA-S5 all provide a higher degree of long-term effectiveness and permanence. Since the greatest volume of soil contamination is taken off-site for disposal in RA-S5, this alternative is slightly more effective and provides the highest level of permanence. Consolidation and use of a low-permeability cover is a proven technology to eliminate exposure to waste material and is effective in the long-term as long as it is regularly maintained. Adding a treatment component to RA-S3 and RA-S4 soils (and possibly LNAPLs and sediment) prior to capping enhances the permanence of immobilizing contaminants and prevents further leaching to ground water. Prior to treatment, dewatering may be necessary for all alternatives. Thermal treatment of organics in RA-S3, though proven, is a more complex technology than the stabilization processes that would be used in RA-S4.

All three alternatives would include long-term monitoring and institutional controls which would ensure appropriate land use and that GW-2 and GW-3 uses are protected.

Ground Water Alternatives

The magnitude of residual risk under RA-G1 is higher than RA-G2 in that the former does not include institutional controls that would ensure that ground water is not inappropriately used for drinking water, that shallow ground water is not exposed during utility work, nor does it include long-term monitoring to ensure that contaminated ground water is not migrating to off-site receptors and to ensure that intermedia of contaminants is degrading surface water via ground water seeps into the Rumford River.

Monitoring and institutional controls in RA-G2 will be effective in the long-term as long as they are maintained and enforced.

6.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Soil Alternatives

Alternatives RA-Sl and RA-S2 do not employ active removal or treatment processes to address soil contamination and therefore would not satisfy CERCLA's statutory preference for treatment as a principal component for soil remedial action.

Alternatives RA-S3 and RA-S4 employ active treatment for some soils and possibly sediments. RA-S3 provides the most reduction of toxicity through both a thermal treatment process for organics and a stabilization process for inorganics. RA-S4 may provide similar reductions in toxicity by applying a stabilization process to both organics and inorganics. A treatability study will be required to determine the correct stabilization agents. In addition, both of these alternatives reduce mobility of Site contaminants placed beneath the low permeability cover by preventing precipitation from coming in contact with the waste causing further leaching to ground water.

Alternative RA-S5 does the least to reduce toxicity of Site contamination in that it does not involve treatment; however, it does remove the highest volume of contamination off-site and as a result, contaminant mobility. Alternative RA-S3 leaves the most onsite in that only dioxin contaminated soil is sent off-site for disposal. LNAPL soil is ultimately disposed of under the low permeability cover after treatment. RA-S4 sends soil containing both dioxin and LNAPL off-site for disposal.

With all alternatives, soil near the railroad tracks will be evaluated during design and may be left onsite with institutional controls to prevent inappropriate land use or contact.

Depending on what facilities are available at the time of the remedial action, it is possible that some material shipped off-site may require treatment prior to final disposal.

Ground Water Alternatives

Neither alternative includes treatment processes and no media would be treated; similarly no hazardous material is removed or treated. Reductions to toxicity and volume of ground water contaminants would occur through natural processes; however, the Rumford River appears to act as a hydraulic barrier to off-site mobility of ground water contamination.

Ground water contamination will remain onsite until reduced/eliminated through natural processes which is estimated to be many years or decades. This time period would be shortened if these alternatives are combined with alternatives RA-S3, RA-S4, or RA-S5.

6.3.5 Short-Term Effectiveness

Soil Alternatives

Because Alternative RA-S1 would not require any action to be conducted, there would not be any short-term impacts on the community or on-site workers. Installing additional monitoring wells in RA-S2 results is negligible short-term impacts to the community and minimal impacts to Site workers. Any harm to wetlands from well drilling and installation would be restored. Neither of these alternatives would achieve remedial action objectives for many years, or even decades.

Alternatives RA-S3, RA-S4, and RA-S5 all include excavation of Site soils and RA-S3 and RA-S4 also include treatment and capping components. These activities would have some short-term impacts on the community and the workers through potential increased truck traffic, air emissions and, for the workers, material handling risks. Personal protective equipment and engineering controls (including air monitoring) would be required. A traffic plan would be implemented to minimize traffic impacts, including the potential use of railroad transport for materials shipped from the Site. Appropriate health and safety requirements would be followed to reduce risk to on-site workers.

Alternatives RA-S3 and RA-S5 would result in the greatest level of short-term risk to the community and workers due to addition of thermal treatment in RA-S3 and the high volume of off-site transportation needed in RA-S5. Thermal treatment is a complex technology and may require extra material handling. It also generates air emissions which would be controlled through engineering means and monitored. In RA-S5, although transportation could be completed by rail, this alternative will result in the greatest potential level of increased truck traffic, noise and dust generation. This scenario would represent the most risk to nearby residents and people located along the transportation route.

The time to achieve RAOs for RA-S3 and RA-S4 is approximately 18 to 24 months; for RA-S5, approximately 15 to 20 months.

Ground Water Alternatives

Installation of monitoring wells and period sampling in RA-G2 will have negligible impacts on the surrounding community and minimal impacts to Site workers. A Site-specific Health and Safety Plan will be required for this work. Alternative RA-G1 has no impacts since no construction activities are planned.

Similarly, without construction RA-G1 has no short-term impacts to the environment. Fencing, signs and monitoring well installation required in RA-G2 would have slight impacts on wetlands—any damage would be restored.

Ground water contamination will remain onsite for many years or decades; however, installing additional monitoring wells, and developing a long-term monitoring plan and implementing deed restrictions a required by RA-G2 could be accomplished within approximately 6 to 12 months.

6.3.6 Implementability

Soil Alternatives

Alternative RA-S1 requires no remedial action and so is easily implementable. While RA-S2 requires only implementation of institutional controls and monitoring, coordination with the Towns and the railroad will be necessary to effectuate this remedy.

Alternatives RA-S3, RA-S4, and RA-S5 utilize reliable waste disposal technologies with proven histories of success. Treatment technologies for RA-S3 (thermal treatment for organics) and RA-S4 (stabilization for inorganics and possibly organics) are more complex but have been used effectively at other sites. Implementability rates high for these alternatives; however, logistical implementation issues exist with RA-S3 and RA-S4 due to the limited area of the Site to provide workspace as well as the need to site a location on-site to which to consolidate material that is to remain after treatment. Excavation activities near the railroad track may require specialized design and construction methods and coordination with the railroad to ensure track integrity. All active source control remedial alternatives (RA-S2, RA-S3, RA-S4, RA-S5 may encounter some implementability issues with regard to movement of material and equipment from one side of the railroad tracks.

Engineering and construction services, equipment, and materials are readily available to implement any of the alternatives.

Ground Water Alternatives

Alternative RA-G1 does not involve the use of technology or construction. There is nothing to operate or monitor. No approvals, coordination or off-site services are required nor any type of administrative process.

Alternative RA-G2 is easily implementable. Monitoring/sampling methods are well developed and routinely performed. Fencing is a standard field task. Implementing and enforcing land use restrictions would require coordination and cooperation with local officials. Anticipated restrictions, when this alternative is teamed RA-S3, RA-S4 or RA-S5 do not appear to conflict with local reuse plans.

Well drillings would produce minimal material for off-site disposal for which licensed facilities are available. No special equipment is necessary.

6.3.7 Cost

Soil Alternatives

Capital, operations and maintenance, and present worth costs were estimated for all alternatives and separate costs are presented for residential versus commercial exposure scenarios. Cost estimates for these alternatives all included similar expense for long-term environmental monitoring.

There are no costs associated with Alternative RA-Sl, so it is the least costly remedial alternative.

The costs for Remedial Alternatives RA-S2, RA-S3, RA-S4, RA-S5 are presented in Tables 5.4-4, through 5.4-7.

Ground Water Alternatives

Like the soil no action alternative, there are no costs associated with the ground water no action alternative, RA-G1.

Costs for RA-G2 are presented in Table 5-4.8.

Tables

Table 1.5-1 Risks Exceeding EPA's Cancer Risk Range and/or Hazard Index for Non-Carcinogenic Effects						
Residential Scenarios (Foxborough Lot Only)						
Medium	**Location**	**Receptor**	**COPC (present cancer risk of >10-6 or HI >1)**	**Exposure Route**	**Carc Risk**	**Non-Carc Risk**
Surface Soil	Process Area	Current & Future Resident	Arsenic, Chromium, Benzo(a)pyrene, Dioxin	Ingestion & Dermal Contact	2.E-03	3.E+01
Subsurface Soil	Process Area	Future Resident	As, PCP, Dioxin, Benzo(a)pyrene	Ingestion & Dermal Contact	5.E-04	5.E+00
Ground Water	Deep	Future Resident	PCP, As, Benzo(a)pyrene, Chromium, Manganese	Ingestion & Dermal Contact	8.E-03	5.E+01
Groundwater	Shallow	Future Resident	PCP, As, Dioxin, Benzo(a)pyrene, Chromium, Manganese, 2,4,6-Trichlorophenol, 2,3,5,6-Trichlorophenol, Vinyl Chloride, Trichloroethene	Ingestion & Dermal Contact	7.E-02	5.E+02
Groundwater	Overburden (off-site)	Future Swimming Pool (off-site)	2-Methylnaphthalene, Pentachlorophenol, Dioxin, Arsenic	Ingestion and Dermal	4E-04	4E+00
Commercial Scenarios						
Surface Soil	Process Area	Future Commercial Worker	Dioxin, As, Benzo(a)pyrene	Ingestion & Dermal Contact	1.E-03	7E+00
Subsurface Soil	Process Area	Future Commercial Worker	As, PCP, Dioxin, Benzo(a)pyrene	Ingestion & Dermal Contact	3.E-04	<1E+00
Surface Soil	Process Area	Current Trespasser	As	Ingestion and Dermal Contact	1E-04	2.0
Surface Soil	Process Area	Future Trespasser	Dioxin, As	Ingestion and Dermal Contact	2E-04	3E+00
Surface Soil	Process Area	Future Town Worker	Dioxin, As	Ingestion and Dermal Contact	3E-04	<1
Surface Soil	Process Area	Utility Worker	As	Ingestion and Dermal Contact	<1E-06	3E+00

Table 2.2-1: Soil PRGs				
Compound	***Residential***		***Commercial/Open Space***	
	PRG (ppm)	***Basis***	***PRG (ppm)***	***Basis***
Benzo(a)pyrene	--**		2.1	1×10^{-5}
Dioxin TEQ*	--**		0.005	$3x10^{-4*}$
Arsenic	9.1	1×10^{-5}	16	1×10^{-5}
Pentachlorophenol	--**		90	1×10^{-5}
Cumulative Risk	**1×10^{-5}**		**3.3×10^{-4}**	

* Dioxin TEQ PRG set based on OSWER Directive 9200.4-26, April 13, 1998, Approaches for Addressing Dioxin in Soil at CERCLA and RCRA Sites. The cleanup level for commercial reuse is 5-20 ppb, while that for residential reuse is 1 ppb. The 5 ppb level is being proposed as the PRG for the commercial future use.

** The Residential RAFU portion of the site did not contain these contaminants at levels that exceeded the calculated PRGs.

Table 2.2-2: Ground Water PRGs		
Compound	***PRG (ppb)***	***Basis***
Pentachlorophenol	1,792	AWQC
Arsenic	17,924	AWQC
Chromium	1,314	AWQC

Note:
PRGs represent maximum concentrations that are protective of ambient water quality criteria (AWQC) in the Rumford River under low flow conditions (See Appendix F).

Table 2.4-1: Soil Remediation Volumes	
Location	***Volume (cy)***
Soil	
Process Area (north of railroad tracks)	28,410
SE/SW Area (south of railroad tracks)	2,478
TOTAL	**30,888**

See alternative specific cost tables 5.4-4 through 5.4-7 for further breakdown of volumes.

Table 3.2-1: Initial Screening of Process Options					
General Response Actions	**Remedial Technology**	**Process Options**	**Description**	**Screening Comments**	**Retained for Further Evaluation**
			SOIL*		
No Action	None	None	No action	Required for consideration under NCP.	Yes
Institutional Controls	Access Restrictions	Deed Restrictions	Restrict future Site usage to minimize contact with soils.	Will not satisfy remedial action objectives as standalone remedy. Could be used in combination with other options.	Yes
		Fencing/Signs	Maintain Site boundary fence to limit access. Post No Trespassing signs.	Will not satisfy remedial action objectives as standalone remedy. Could be used in combination with other options.	Yes
Removal	Removal	Excavation	Physically remove soil from Site.	Excavation may be necessary as part of an ex-situ treatment process or for the disposal of contaminants either off-site or on-site.	Yes
Ex-situ Treatment	Biological Treatment	Bioreactor or 'Biopile'	Biological oxidation of organic contaminants using indigenous or engineered microorganisms.	Presumptive remedy for wood treater sites with organic contamination. Run times to reach cleanup levels can be lengthy; subject to potential upsets.	Yes
	Thermal Treatment	Thermal Desorption	Soil and sediment is treated using a heated air stream/vacuum unit to remove organic materials.	Presumptive remedy for wood treater sites with organic contamination.	Yes

* Sediment in potential vernal pools may require remediation if further studies conducted during remedial design indicate an ecological risk exists. Sediment will be addressed using the same technology applied to soils.

Table 3.2-1: Initial Screening of Process Options					
General Response Actions	**Remedial Technology**	**Process Options**	**Description**	**Screening Comments**	**Retained for Further Evaluation**
		Incineration	Volatilizes organic contaminants by heating to temperatures greater than 1,000°F. Off-gas treatment necessary.	Presumptive remedy for wood treater sites with organic contamination. Requires off-site shipment of waste.	Yes
	Immobilization/ Stabilization	Pozzolan/ Portland Cement/ Other Stabilization Agent(s)	Stabilizes and solidifies contaminated soil.	Presumptive remedy for wood treater sites with inorganic contamination. EPA research indicates potential application to organic wastes as well (See Appendix G).	Yes
In-situ Treatment (soil only)	Biological Treatment	Enhanced Biodegradation	Biological oxidation of organic contaminants using indigenous or engineered microorganisms.	Presumptive remedy for wood treater sites with organic contamination. Potential for long run times to reach cleanup goals; subject to potential process upsets.	Yes
		Natural Attenuation	Removal of organic contaminants through microbial degradation.	Unlikely to reach cleanup goals within a reasonable timeframe.	No
	Thermal Treatment	Thermal Desorption	Soil is heated in-situ to high temperatures. Volatilized compounds collected using vapor extraction system.	Presumptive remedy for wood treater sites with organic contamination.	Yes
	Immobilization	Pozzolan/ Portland Cement	Stabilizes and solidifies contaminated soil in place.	Presumptive remedy for wood treater sites with inorganic contamination.	Yes
Containment	Surface Controls	Capping	Placement of low permeable cover over consolidated soils.	Commonly used for soils.	Yes

Table 3.2-1: Initial Screening of Process Options					
General Response Actions	**Remedial Technology**	**Process Options**	**Description**	**Screening Comments**	**Retained for Further Evaluation**
Disposal	On-site Disposal	Consolidate	Consolidate materials on Site under appropriate cap.	Proven technology with long-term track record.	Yes
	Off-site Disposal	Off-site Landfill	Transport materials off-site to permitted facility.	Easily implementable; proven track record.	Yes
SURFACE WATER†					
No Action	None	None	No action	Required for consideration under NCP.	Yes
Institutional Controls	Access Restrictions	Deed Restrictions	Restrict future Site usage to minimize contact with surface water.	Potentially applicable.	Yes
		Fencing/Signs	Maintain Site boundary fence to limit access. Post No Trespassing signs.	Potentially applicable.	Yes
	Monitoring	Periodic Surface Water Monitoring	On-going monitoring of surface water.	Potentially applicable.	Yes
GROUND WATER‡					
No Action	None	None	No action	Required for consideration under NCP.	Yes
Institutional Controls	Access Restrictions	Deed Restrictions	Prohibit use of drinking water wells at Site.	Potentially applicable.	Yes
	Monitoring	Periodic Ground Water Monitoring	On-going monitoring of wells.	Monitoring is relatively low cost, easily implemented, and effectively tracks potential migration of groundwater plume.	Yes

† Surface water options would be necessary to ensure Class B use is not threatened by groundwater.

‡ Given the state's determination that the groundwater is of low use and value, groundwater process options apply only to groundwater resulting from dewatering activities during soil excavation , to ensure that contaminated groundwater does not migrate to offsite receptors, and to maintain GW-2 and 3 uses.

Table 3.2-1: Initial Screening of Process Options					
General Response Actions	**Remedial Technology**	**Process Options**	**Description**	**Screening Comments**	**Retained for Further Evaluation**
Removal	Dewatering	Pumping and discharge to surface water	Physically remove groundwater from soil as needed for excavation and divert through treatment system or dispose off-site.	Easily implemented, long term track record. Applicable as a technology to facilitate excavation.	Yes
Ex-situ Treatment	Biological	Bioreactor	Biological oxidation of organic contaminants collected in dewatering using indigenous or engineered microorganisms.	Not effective on inorganic compounds such as Arsenic.	No
	Physical/ Chemical Separation	Granulated Activated Carbon (GAC)	Physical treatment of organic contaminants collected in dewatering using GAC.	Proven technology. Applicable as a technology to facilitate excavation.	Yes
		Filtration/ Ultrafiltration/ Microfiltration	Mechanical separation based on particle size whereby particles suspended in a fluid are separated by forcing the fluid through a porous medium.	Amount of O&M based on volume of potential ground water makes this option cost-prohibitive.	No
		Chemical Precipitation	Transforms dissolved contaminants into an insoluble solid, facilitating the contaminant's subsequent removal from the liquid phase by sedimentation or filtration. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation.	Not effective on most organic contaminants.	No

Table 3.2-1: Initial Screening of Process Options					
General Response Actions	**Remedial Technology**	**Process Options**	**Description**	**Screening Comments**	**Retained for Further Evaluation**
		Chemical/ UV Oxidation	Constituents in water are oxidized to less toxic compounds by the application of an oxidizing agent.	Not effective on PAH compounds. Would require treatability study.	No
		Air Stripping	Extracted ground water would be pumped through an air stripper column. VOCs would be transferred to the vapor phase. Off gas would be treated with activated carbon.	Not effective on SVOCs and inorganics.	No
Disposal	Off-site Disposal	Transport to POTW	Transport materials off-site to permitted facility.	Potential volume of groundwater and location of nearest POTW makes this option cost-prohibitive.	No
	On-site Disposal	Pipeline to River	Transports treated groundwater to River.	Effective. Straightforward to implement.	
LNAPL[§]					
No Action	None	None	No action	Required for consideration under NCP.	Yes
Removal	Removal	Excavation	Physically remove LNAPL and LNAPL-saturated soil from Site.	Easily implemented technology. Relatively small areas exhibit measurable levels of LNAPL.	Yes

[§]LNAPL is being addressed to prevent degradation to surface water via groundwater which transport the LNAPL.

Table 3.2-1: Initial Screening of Process Options					
General Response Actions	**Remedial Technology**	**Process Options**	**Description**	**Screening Comments**	**Retained for Further Evaluation**
Withdrawal/ Collection	LNAPL Extraction	Dual-Phase Extraction	A high vacuum system is applied to simultaneously remove various combinations of contaminated ground water, separate-phase petroleum product, and hydrocarbon vapor from the subsurface.	The target contaminant groups for dual phase extraction are VOCs and LNAPLs. Dual phase vacuum extraction is more effective than SVE for heterogeneous clays and fine sands.	Yes
		Sorbent Collection	Sorbent material or "pillows" are placed in areas containing free product; LNAPL is absorbed and then removed along with the sorbent material.	Easily implemented technology.	Yes
In-situ Treatment	Physical	Soil Vapor Extraction/ Air Sparge	Air is injected into saturated matrices to remove contaminants through volatilization. Vapor phase is collected through a series of vapor extraction wells.	Effective on dissolved phase fuel contaminants. Limited effectiveness on LNAPL.	No
		Bioslurping	Bioslurping combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated soils. Vacuum-enhanced free-product recovery extracts LNAPLs from the	Bioslurping can be successfully used to remediate soils contaminated by petroleum hydrocarbons. It is a cost-effective in situ remedial technology that simultaneously accomplishes LNAPL removal and soil remediation of VOCs in the vadose zone	No

Table 3.2-1: Initial Screening of Process Options					
General Response Actions	**Remedial Technology**	**Process Options**	**Description**	**Screening Comments**	**Retained for Further Evaluation**
			capillary fringe and the water table.		
Ex Situ Treatment	Thermal Treatment	Thermal Desorption	Transport to thermal desorber. LNAPL is collected as condensate for disposal off-site.	Potentially applicable.	Yes
Disposal	On-site Disposal	Consolidate	Consolidate LNAPL with other materials on Site.	Not Effective in meeting remediation goals for the Site. Not applicable.	No
	Off-site Disposal	Off-site Landfill	Transport materials off Site to permitted disposal facility.	Potentially applicable	Yes
		Treatment/ Recycling Facility	Transport materials off-site to permitted facility such as asphalt batch plant to treat or recycle material.	Potentially applicable	Yes

Table 3.3-1: Evaluation of Process Options						
General Response Actions	**Remedial Technology**	**Process Options**	**Effectiveness**	**Implementability**	**Relative Cost**	**Retained?**
SOIL						
No Action	None	None	Does not achieve remedial action objectives.	Not applicable.	None.	Yes
Institutional Controls	Access Restrictions	Deed Restrictions	Effectiveness depends on future implementation. Does not reduce contamination.	Easily implemented; administratively feasible.	Low capital costs; low O&M costs.	Yes
		Fencing/Signs	Moderately effective in reducing potential exposure. Does not reduce contamination.	Easily implemented.	Low capital costs; moderate O&M costs.	Yes
Removal	Removal	Excavation	Effective in removing contaminants.	Easily implemented.	Moderate costs.	Yes
Ex-situ Treatment	Biological Treatment	Bioreactor or Biopile	Could permanently destroy organics in soil/sediment. However, is not effective on most inorganics; metals such as arsenic inhibit biological treatment process. Would not be effective at this Site because soil and sediment to be remediated contains both metals and organics.	Readily implemented. Long time frame required to biologically destroy organic contaminants in cold-weather climate. Not readily implemented in phased cleanup.	Moderate capital costs; moderate O&M costs.	No
	Thermal Treatment	Thermal Desorption	Limited effectiveness on dioxins. Not effective in treating inorganics. Could effectively remove organics including LNAPL from soil.	Readily implemented, but must be combined with treatment of inorganics. Phased cleanup schedule would create implementability issues.	High capital costs; low O&M costs. Costs increase if cleanup is phased.	Yes

Table 3.3-1: Evaluation of Process Options						
General Response Actions	**Remedial Technology**	**Process Options**	**Effectiveness**	**Implementability**	**Relative Cost**	**Retained?**
		Incineration	Effective for destruction of dioxins. Not effective in treating inorganics. Might be effective as one in a series of process options.	Onsite incineration unlikely due to high mobilization and staging costs. Potentially could be applied to materials shipped off-site to existing commercial facility.	High capital costs on-site; moderate costs for shipments to off-site facility..	yes
	Immobilization/ stabilization	Pozzolan/ Portland Cement/ Stabilization Agent(s)	Reduces mobility of inorganics. Treatability study required. Some EPA studies indicate potential application to organics at Site as well.	Readily implemented. Materials & equipment are readily available.	Moderate capital costs; low O&M costs.	Yes
In-situ Treatment (soil only)	Biological Treatment	Enhanced Biodegradation	Permanently destroys organics. Inorganics mixed with organics make this process ineffective due to toxicity of arsenic.	Easily implemented.	Moderate capital costs; moderate O&M costs.	No
		Natural Attenuation	Permanently destroys organics. Not effective on most inorganics which also will inhibit biological growth.	Easily implemented. May take many years to destroy organics.	Low capital costs; moderate O&M costs.	No
	Thermal Treatment	Thermal Desorption	Limited effectiveness on dioxins. Not effective in treating inorganics.	Readily implemented for organics, but must be combined with treatment of inorganics.	High capital costs; low O&M costs.	Yes

Table 3.3-1: Evaluation of Process Options						
General Response Actions	**Remedial Technology**	**Process Options**	**Effectiveness**	**Implementability**	**Relative Cost**	**Retained?**
	Immobilization	Pozzolan/ Portland Cement	Reduces mobility of inorganics. Treatability study required. Potentially effective on organics as well.	Readily implemented. Materials are readily available. In-situ treatment will require specialized mixing equipment.	Moderate to high capital costs; low O&M costs.	Yes
Containment	Surface Controls	Rip Rap Barrier	Moderately effective in reducing potential exposure. Does not reduce contamination.		Low capital costs.	Yes
		Capping (low-permeability)	Effective at preventing exposure. Does not reduce contamination.	Easily implemented, proven technology	Moderate costs	Yes
Disposal	On-site Disposal	Consolidate under appropriate cover.	Contains but does not treat contaminants.	Implementable.	Moderate capital costs for design construction. O&M cost will depend on nature of containment technology.	Yes
	Off-site Disposal	Off-site Landfill	Removes untreated contaminants from Site.	Implementable. Presence of dioxin in some samples from the Site potentially complicates disposal of some materials from the Site.	High costs for disposal at permitted facility	Yes
SURFACE WATER						
No Action	None	None	Does not achieve remedial action objectives.	Not applicable.	None.	Yes.

Table 3.3-1: Evaluation of Process Options						
General Response Actions	**Remedial Technology**	**Process Options**	**Effectiveness**	**Implementability**	**Relative Cost**	**Retained?**
Institutional Controls	Access Restrictions	Activity and Use Limitations, Deed Restrictions	Effectiveness at preventing exposure depends on future implementation. Does not reduce contamination.	Easily implemented.	Low capital costs, low O&M costs.	Yes
	Monitoring	Periodic Surface Water Monitoring	Useful for documenting conditions. Does not reduce contaminants or associated risk from contaminants.	Easily implemented.	Low capital costs; low O&M costs.	Yes
GROUND WATER						
No Action		Periodic Ground Surface Water Monitoring	Useful for documenting conditions. Does not reduce contaminants or associated risk from contaminants.	Easily implementable.	Low capital costs; low O&M costs.	Yes
Institutional Controls	None	Extraction Wells	Extraction wells would remove contaminated ground water and prevent migration to downgradient areas.	Installation would be conducted using conventional well drilling techniques. Experienced personnel are available.	Low to moderate capital. Low O&M.	Yes
	Access Restrictions	Bioreactor	Biological treatment would effectively remove some organic contaminants. Ground water would require metals pretreatment.	Biological treatment in the form of fixed film towers or suspended growth systems are available and commonly used to remove organics from water.	Moderate capital. Moderate to high O&M.	Yes
LNAPL						
No Action	None	None	Does not achieve remedial objectives.	Not applicable.	None	Yes

Table 3.3-1: Evaluation of Process Options						
General Response Actions	**Remedial Technology**	**Process Options**	**Effectiveness**	**Implementability**	**Relative Cost**	**Retained?**
Removal	Removal	Excavation	Effective in removing LNAPL in soil.	Easily implemented.	Moderate costs.	Yes
Withdrawal/ Collection	LNAPL Extraction	Dual-Phase Extraction	More effective than SVE for heterogeneous clays and fine sands	Easily implemented using conventional well installation techniques.	Moderate capital costs; moderate O&M costs.	Yes.
		Sorbent Extraction	Effective	Easily implemented	Moderate capital costs; low O&M costs	Yes
		Bioslurping	Effective in removing LNAPL from ground water. Cold temperature can inhibit LNAPL collection.	Easily implemented using conventional well installation techniques.	Moderate capital costs; moderate O&M costs.	No
In-situ Treatment	Physical	Bioslurping	Effective in removing LNAPL from groundwater. Cold temperature can inhibit LNAPL collection.	Easily implemented using conventional techniques, except that cold temperatures will inhibit collection.	Moderate capital costs, moderate O&M costs	No
Ex-situ treatment	Physical	Thermal desorption	Effective at removing LNAPL from soil matrix.	Easily implemented; LNAPL-contaminated soil could be combined with other soil undergoing thermal treatment.	Moderate	Yes
Removal	Physical	Treatment/ Recycling Facility	Effective in removing secondary source area.	Easily implemented; LNAPL-contaminated soil could be combined with other soil undergoing thermal treatment.	High capital costs. Costs increase if cleanup is phased. Low O&M costs.	Yes
Disposal	Off-site Disposal	Off-site Landfill	Effective in removing secondary source area.	Transportation issues would be critical in making this implementable.	Moderate capital costs, moderate O&M costs	Yes

Table 3.3-1: Evaluation of Process Options						
General Response Actions	**Remedial Technology**	**Process Options**	**Effectiveness**	**Implementability**	**Relative Cost**	**Retained?**
	On-site Disposal	Consolidate under appropriate cover	Contains but does not treat contaminants. Must be combined with other technologies to be effective.	Implementable.	Moderate capital costs for design construction. O&M possible depending on nature of containment technology.	No

Table 4.0-1: Remedial Alternative Technologies

Remedial Alternative		Media								
		Soil							***Ground Water***	
		Institutional Controls	Low Permeability Cover	Excavation	Thermal Desorption	Stabilization	Off-site disposal	Dredge and treat with soil	Long Term Monitoring	Institutional Controls
RA-S1	**No Action**									
RA-S2	**Limited Action**	●								
RA-S3	**Thermal desorption of PCP and LNAPL soils, Stabilize and Consolidate arsenic soils under low permeability cover, dispose dioxin soils off-site**	●	●	●	●	●	●	●		
RA-S4	**Stabilize and Consolidate arsenic and organic containing soils under low permeability cover, dispose dioxin and LNAPL soils off-site**	●	●	●		●	●	●		
RA-S5	**Excavation/off-site disposal**	●		●			●	●		
RA-G1	**No Action**									
RA-G2	**Limited Action**								●	●

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	***RA-S1 No Action***	***RA-S2 Limited Action***	***RA-S3 Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S4 Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S5 Excavation/Off-site Disposal***
Overall Protection of Human Health and the Environment Human Health Protection Ecological Protection	No reduction in risk. Contaminants would continue to pose a risk from dermal contact and ingestion of soils. Source areas continue to leach into ground water uncontrolled and undetected. Further study of vernal pool habitat would not occur to determine whether or not risk is present.	Some reduction in risk to human health accomplished by land use restrictions, including residential development. Source area contamination would continue to leach into ground water resulting in intermedia transfer of contaminants and jeopardizing GW-2 and GW-3 uses. Fencing may minimize trespassing and access to Site soils and the Rumford River. Railroad track area soil and	Excavation, treatment and capping of soils and, if necessary, sediments provides needed overall protection of human health and the environment. Removal of hot spot LNAPLs will minimize contaminated groundwater seeps to the Rumford River. Soil exposures within rail right of way will be evaluated and appropriate action taken if necessary. Further studies, risk evaluation and action, if necessary of potential vernal pool sediments will ensure ecological protection. Monitoring would determine whether waste left on-site is leaching into ground water	Excavation, treatment and capping of soils and, if necessary, sediment provides needed overall protection of human health and the environment. Removal of hot spot LNAPLs from the groundwater table will minimize contaminated groundwater seeps to the Rumford River. Soil exposures within rail right of way will be evaluated and appropriate action taken if necessary. Further studies, risk evaluation and action, if necessary of potential vernal pool sediments will ensure ecological protection. Monitoring would determine whether waste left on-site is leaching into groundwater resulting in	Excavation and off-site disposal of contaminated soils, LNAPL and, if necessary, sediment provides needed overall protection of human health and the environment. Removal of hot spot LNAPLs from the groundwater table will minimize contaminated groundwater seeps to the Rumford River. Soil exposures within rail right of way will be evaluated and appropriate action taken if necessary. Further studies, risk evaluation and action, if necessary of potential vernal pool sediments will ensure ecological protection. Monitoring would determine whether any

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	***RA-S1 No Action***	***RA-S2 Limited Action***	***RA-S3 Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S4 Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S5 Excavation/Off-site Disposal***
Overall Protection of Human Health and the Environment (continued)		vernal pool habitat would not be evaluated.	resulting in intermedia transfer of contaminants and jeopardizing GW-2 and GW-3 conditions.	intermedia transfer of contaminants and jeopardizing GW-2 and GW-3 conditions.	waste left on-site is leaching into groundwater resulting in intermedia transfer of contaminants and jeopardizing GW-2 and GW-3 conditions.
Compliance with ARARs Chemical specific	See Table 5.5-3 for action specific ARARs. This alternative would not comply with soil cleanup levels	See Table 5.5-3 for action specific ARARs. This alternative would not comply with soil cleanup levels.	See Table 5.5-3 for action specific ARARs.. This alternative will comply with all chemical-specific ARARs.	See Table 5.5-3 for action specific ARARs. This alternative will comply with all chemical-specific ARARs.	See Table 5.5-3 for action specific ARARs. This alternative will comply with all chemical specific ARARs.
Location specific	There are no location-specific ARARs for this Alternative.	This alternative will comply with all location-specific ARARs.	This alternative will comply with all location-specific ARARs.	This alternative will comply with all location-specific ARARs.	This alternative will comply with all location-specific ARARs.
Action specific	There are no Action-specific ARARs for this Alternative.	This alternative will not comply with all action–specific ARARs.	This alternative will comply with all action-specific ARARs.	This alternative will comply with all action-specific ARARs.	This alternative will comply with all action-specific ARARs. .

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	***RA-S1*** ***No Action***	***RA-S2*** ***Limited Action***	***RA-S3*** ***Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S4*** ***Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S5*** ***Excavation/Off-site Disposal***
Long-Term Effectiveness & Permanence Magnitude of residual risk Adequacy and reliability of controls	This alternative would not remove or contain contaminated soil, LNAPL or, if necessary, sediment. Contaminants would continue to leach to groundwater, further threatening Rumford River surface water. The residual risk would remain high at this Site because waste remains unaddressed. There would be no controls in place.	This alternative would address soil and potential sediment contact risks because it would not remove or contain contaminated soil, or, if necessary, sediment. It relies solely on the success of institutional controls, monitoring, and natural attenuation. The magnitude of the residual risk is high. Adequacy of institutional controls and monitoring is moderate in that their effectiveness lies in the continued enforcement of	Off-site disposal of dioxin contaminated soil, thermal treatment of PCPs (and potentially LNAPL soil) along with stabilization of arsenic contaminated soils and sediment, if necessary, will significantly reduce the residual risks left on-site. Consolidation of treated soils under a low permeability cover will prevent dermal contact with any remaining contaminants in the consolidated soils. Removal of hot spot LNAPL soil and associated free product (and potential thermal treatment) before consolidation will substantially reduce intermedia transfer of contaminants to the Rumford River.	Offsite disposal of dioxin and LNAPL contaminated soil, stabilization of arsenic and PCP contaminated soils (and sediment, if necessary), will significantly reduce the residual risks left on-site . Soils contaminated with PCPs and SVOCs (and any other organics) will be stabilized before consolidation if they fail leaching tests to further reduce residual Site risks. Consolidation of treated soils under a low permeability cover will prevent dermal contact with any remaining contaminants in the consolidated soils. Removal of hot spot LNAPL soil and associated free product for off-site disposal will substantially reduce intermedia transfer of contaminants to the	Excavation and off-site disposal of contaminated soil, LNAPL and, if necessary, sediment will significantly reduce the residual risks left on-site. Removing hot spot contaminated LNAPL soil and associated free product will eliminate leaching to groundwater substantially reducing intermedia transfer of contaminants to the Rumford River. Institutional controls will be necessary to ensure appropriate land and groundwater use. Some risk may remain if soil around rail area is evaluated and institutional controls are implemented. Regular inspection and maintenance of the monitoring wells (and any necessary fencing and signage) will be required

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	*RA-S1 No Action*	*RA-S2 Limited Action*	*RA-S3 Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover*	*RA-S4 Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover*	*RA-S5 Excavation/Off-site Disposal*
Long-Term Effectiveness & Permanence (continued)		land use restrictions and maintenance of fencing and monitoring wells.	Institutional controls will be necessary to ensure appropriate land and groundwater use. Some risk may remain if soil around rail area is evaluated and institutional controls are implemented. Regular inspection and maintenance of the low permeability cover, fencing, signs and monitoring wells will be required as well as continued enforcement of institutional controls.	Rumford River. Institutional controls will be necessary to ensure appropriate land and groundwater use. Some risk may remain if soil around rail area is evaluated and institutional controls are implemented. Regular inspection and maintenance of the low permeability cover, fencing, signs and monitoring wells will be required as well as continued enforcement of institutional controls.	as well as continued enforcement of institutional controls.

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	***RA-S1 No Action***	***RA-S2 Limited Action***	***RA-S3 Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S4 Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S5 Excavation/Off-site Disposal***
Reduction of Toxicity, Mobility & Volume Through Treatment Treatment process used and materials treated Amount of hazardous materials removed or treated Degree of expected reductions in toxicity, mobility and volume Degree to which treatment is reversible Type/quantity of residuals remaining after treatment	This alternative does not meet this criteria since it does not include treatment. No treatment processes are proposed nor media treated. No hazardous material is removed or treated. Minimal reduction of toxicity, mobility and volume would occur through natural processes. Site conditions would remain unchanged.	This alternative does not meet this criteria since it does not include treatment. Reductions depend solely on natural processes. COCs in soil and groundwater would remain toxic and mobile for many years or possibly decades.	The toxicity and mobility of PCPs, arsenic, SVOCs and LNAPLs would be permanently minimized as a result of the thermal treatment of the organic contaminants and stabilization of inorganics. Thermal treatment and stabilization followed by consolidation and capping also eliminates infiltration of remaining contaminants to groundwater. Volume and toxicity of dioxin contaminated soil would be permanently eliminated via off-site disposal. Removal of LNAPL soil and associated free product eliminates mobility of contaminants and inter-media transfer to groundwater and, through seeps, to	The toxicity and mobility of PCPs, arsenic, and SVOCs would be permanently minimized as a result of stabilization processes. Stabilization, followed by consolidation and capping also eliminated infiltration of remaining contaminants to groundwater. Volume and toxicity of dioxin and LNAPL contaminated soils would be permanently eliminated via offsite disposal. Removal of LNAPL soil and associated free product eliminates mobility of contaminants and inter-media transfer to groundwater and, through seeps, to surface water. Treated waste will remain on-site under the cap and will require inspection and maintenance. Some risk	Toxicity, mobility and volume of waste on site above target cleanup levels will be substantially reduced by excavation and off-site disposal. Removal of LNAPL free product eliminates mobility of contaminants and inter-media transfer to groundwater and, through seeps, to surface water. Some risk may remain if soil around rail area is evaluated but will be controlled through institutional controls if necessary. Contaminated groundwater remains on-site but does not pose a drinking water risk given its low use and value determination. Some risk remains from dermal contact; deed restrictions

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	*RA-S1 No Action*	*RA-S2 Limited Action*	*RA-S3 Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover*	*RA-S4 Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover*	*RA-S5 Excavation/Off-site Disposal*
Reduction of Toxicity, Mobility and Volume through Treatment (continued)			surfacewater. Treated waste will remain capped on-site and will require inspection and maintenance. Some risk may remain if soil around rail area is evaluated but institutional controls will be implemented, if necessary. Contaminated groundwater remains on-site but does not pose a drinking water risk given its low use and value determination. Some risk remains from dermal contact; deed restrictions on land and groundwater use would minimize this risk. Treatment processes are irreversible. The cap may be removed if necessary.	may remain if soil around rail area is evaluated but institutional controls will be implemented, if necessary. Contaminated groundwater remains on-site but does not pose a drinking water risk given its low use and value determination. Some risk remains from dermal contact; deed restrictions on land and groundwater use would minimize this risk. Treatment processes are irreversible. The cap may be removed if necessary.	on land and groundwater use would minimize this risk. Aside from treating groundwater resulting from any necessary dewatering processes, there are no treatment technologies proposed in this alternative.

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	***RA-S1*** ***No Action***	***RA-S2*** ***Limited Action***	***RA-S3*** ***Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S4*** ***Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S5*** ***Excavation/Off-site Disposal***
Implementability Ability to construct and operate the technology Reliability of the technology Ease of undertaking additional remedial actions if necessary Ability to monitor effectiveness of remedy Availability of prospective technologies Ability to obtain approvals from other agencies	Since there is no use of technology proposed, there will be no construction, nothing to operate and no reliability to evaluate. Additional remedial action could be taken. Without monitoring natural degradation processes could not be evaluated. No approvals, coordination or offsite services There are no Administrative feasibility issues with this alternative. There are no issues related to service and materials for this alternative since no services and	This alternative has high technical feasibility since it relies only on sampling (sampling methods are well developed), installation of fencing (which is a standard field task) and additional monitoring wells. Well drillings would produce minimal material for off-site disposal. Undertaking additional remedial action would be easy. Monitoring groundwater and surface water is routinely performed.	Construction and operation on the Site will be complicated due to the large square footage of targeted excavation areas leaving less area for operations associated with locating the thermal desorption equipment, dewatering, screening, blending, curing consolidating, covering and regrading. Work could be conducted in phases to provide enough working area. Work south of the rail tracks will be difficult to access. Excavation in close proximity to the tracks may require special design and construction methods as well as coordination with railroad to prevent any impact to the tracks. Excavation, stabilization of inorganics, and capping are standard, reliable	Construction and operation on the Site will be complicated due to the large square footage of targeted excavation areas leaving less area for operations associated with dewatering, screening, blending, curing consolidating, covering and regarding. Work could be conducted in phases to provide enough working area. Work south of the rail tracks will be difficult to access. Excavation in close proximity to the tracks may require special design and construction methods as well as coordination with railroad to prevent any impact to the tracks. Immobilization of soils with organics and inorganics is an intricate technology but has been successfully implemented	Construction and operation on the Site will be complicated due to the large square footage of targeted excavation areas leaving less area for operations associated with dewatering, screening, regarding, and loading of contaminated material on trucks or rail for off-site transportation. Work could be conducted in phases to provide enough working area. Work south of the rail tracks will be difficult to access. Excavation in close proximity to the tracks may require special design and construction methods as well as coordination with railroad to prevent any impact to the tracks. Excavation is widely accepted and would be accomplished with conventional equipment

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	***RA-S1 No Action***	***RA-S2 Limited Action***	***RA-S3 Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S4 Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S5 Excavation/Off-site Disposal***
Implementability (continued) Coordination with other agencies Availability of off-site treatment, storage and disposal services and capacity are required	materials are required	Enforcement of land use restrictions would require coordination and cooperation with local officials. Restrictions may conflict with local reuse plans. Coordination and implementation would be required for the long term monitoring and Site inspections that are part of this alternative. Preparation and recording of the institutional controls will be required. All of the needed services and materials are readily available for this	technologies. Thermal desorption for the inorganics is moderately complex but is a proven technology. Stabilization will require treatability tests to arrive at a suitable mixture of stabilization agent(s). Additional excavation can always be completed at a later date. However, once the cap is constructed, areas within the cap footprint would not be easily accessible for future remediation. Long-term monitoring of surface water and groundwater will determine whether the remedy is successful in preventing contaminated groundwater from degrading the Rumford River. Inspections and continuing maintenance	at sites around the country. Excavation, stabilization of inorganics, and capping are standard, reliable technologies. Stabilization will require treatability tests to arrive at a suitable mixture of stabilization agent(s). Additional excavation can always be completed at a later date. However, once the cap is constructed, areas within the cap footprint would not be easily accessible for future remediation. Long-term monitoring of surface water and groundwater will determine whether the remedy is successful in preventing contaminated groundwater from degrading the Rumford River. Inspections and continuing	such as backhoe and excavator. Waste would be transported offsite by dump trucks or rail cars. Additional excavation can always be completed at a later date. Long-term monitoring of surface water and groundwater will determine whether the soil remedy is successful in preventing contaminated groundwater from degrading the Rumford River. Coordination with the railroad will be necessary to ensure excavation does not affect the structural integrity of the track bed. Coordination will also occur with the local conservation commission for work in the wetlands and with affected state

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	***RA-S1 No Action***	***RA-S2 Limited Action***	***RA-S3 Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S4 Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S5 Excavation/Off-site Disposal***
Implement-ability (continued)		alternative.	of the cap would assess cap integrity, vegetative cover and drainage systems. Coordination with the railroad will be necessary to ensure excavation does not affect the structural integrity of the track bed. Coordination will also occur with the local conservation commission for work in the wetlands and with affected state and federal agencies that oversee endangered, threatened or species of special concern or their habitat. Other minor issues are related to coordination with the State to ensure long term monitoring is performed and preparation and recording of the institutional controls.	maintenance of the cap would assess cap integrity, vegetative cover and drainage systems. Coordination with the railroad will be necessary to ensure excavation does not affect the structural integrity of the track bed. Coordination will also occur with the local conservation commission for work in the wetlands and with affected state and federal agencies that oversee endangered, threatened or species of special concern or their habitat. Other minor issues are related to coordination with the State to ensure long term monitoring is performed and preparation and recording of the institutional controls. Equipment and materials	and federal agencies that oversee endangered, threatened or species of special concern or their habitat. Other minor issues are related to coordination with the State to ensure long term monitoring is performed and preparation and recording of the institutional controls. Equipment and materials are generally available for all the processes being proposed as part of this alternative.

Table 5.4-1 Soil Remedial Alternatives Evaluation Summary					
Detailed Analysis Criteria	***RA-S1 No Action***	***RA-S2 Limited Action***	***RA-S3 Thermal Desorption of PCP and LNAPL, Off-site Disposal of Dioxin, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S4 Off-site Disposal of Dioxin and LNAPL, Stabilization of Arsenic and Consolidation Under Low Permeability Cover***	***RA-S5 Excavation/Off-site Disposal***
Implementability (continued)			Equipment and materials are generally available for al the processes being proposed as part of this alternative.	are generally available for all the processes being proposed as part of this alternative.	

Table 5.4-2 Ground Water Remedial Alternatives Evaluation Summary		
Detailed Analysis Criteria	***RA-G1*** ***No Action***	***RA-G2*** ***Limited Action***
Overall Protection of Human Health and the Environment Human Health Protection Ecological Protection	On-site groundwater is contaminated but does not pose a risk to drinking water because the low use and value determination prohibits the use of groundwater as a drinking water source. Shallow groundwater poses a risk if dermal contact occurs. This alternative does not monitor groundwater to ensure that contaminated groundwater is not migrating to off-site receptors. This alternative does not monitor groundwater to ensure that intermedia transfer of contaminants is not occurring between groundwater and surface water. This alternative does not provide for any activities or controls to prevent inappropriate use of groundwater as drinking water or to prevent dermal contact with shallow groundwater.	On-site groundwater is contaminated but does not pose a risk because the low use and value determination prohibits the use of groundwater as a drinking water source. Shallow groundwater poses a risk if dermal contact occurs. Groundwater monitoring would ensure that contaminated groundwater is not migrating to off-site receptors and that intermedia transfer of contaminants is not occurring between groundwater and surface water. This alternative includes institutional controls to prevent inappropriate use of groundwater as drinking water and to prevent dermal contact with shallow groundwater.
Compliance with ARARs Chemical-specific ARARs Location-specific ARARs Action-specific ARARs	See Table 5.5-3 for action specific ARARs. Because this is not a drinking water aquifer, there are no chemical-specific ARARs. Because there are no actions required by this alternative, there are no location specific or action specific ARARs.	See Table 5.5-3 for action specific ARARs. Because this is not a drinking water aquifer, there are no chemical-specific ARARs. This alternative will comply with all location-specific ARARs. This alternative will comply with all action-specific ARARs.

Table 5.4-2 Ground Water Remedial Alternatives Evaluation Summary		
Detailed Analysis Criteria	***RA-G1*** ***No Action***	***RA-G2*** ***Limited Action***
Long-Term Effectiveness & Permanence Magnitude of residual risk Adequacy and reliability of controls	The magnitude of residual risk under this alternative is moderate to high because contamination groundwater remains on-site unmonitored to ensure it is not migrating to off-site receptors or transferring contaminants to surface water via groundwater seeps to the Rumford River. This alternative does not provide for any activities or controls to prevent inappropriate use of or exposure to groundwater.	The magnitude of residual risk under this alternative is low to moderate. Although contaminated groundwater remains on-site, groundwater is not a source of drinking water and migration of contaminated groundwater is monitored to ensure it is not migrating to off-site receptors or transferring contaminants to surface water via groundwater seeps to the Rumford River. Monitoring and institutional controls will be effective in the long-term as long as they are maintained and enforced.
Reduction of Toxicity, Mobility and Volume Through Treatment Treatment process used and materials treated Amount of hazardous materials removed or treated Degree of expected reductions in toxicity, mobility and volume Degree to which treatment is reversible Type and quantity of residuals remaining after treatment	There are no treatment processes proposed and no media would be treated. No hazardous material is removed or treated. Minimum reduction of toxicity, mobility and volume would occur through natural processes. Site conditions would remain unchanged.	This alternative does not include treatment. Reductions of volume and toxicity depend solely on natural processes. Contaminated groundwater would remain on-site. The Rumford River appears to act as a hydraulic barrier to off-site mobility of groundwater contamination. Groundwater contamination will remain on-site until reduced/eliminated through natural processes.
Short-Term Effectiveness	This alternative does not present any short-term risk or impacts to the	Installation of monitoring wells and periodic sampling have minimal impacts on surrounding community and workers; a Site-specific Health

Table 5.4-2 Ground Water Remedial Alternatives Evaluation Summary		
Detailed Analysis Criteria	***RA-G1*** ***No Action***	***RA-G2*** ***Limited Action***
Protection of community during remedial actions Protection of workers during remedial actions Environmental impacts Time until remedial action objectives are achieved	community or workers because no construction activities take place. Without construction there are no short-term impacts to the environment. It will take many years or decades for natural attenuation to address groundwater contamination.	and Safety Plan would be required. Fencing, signs and monitoring well installation would have slight impacts on wetlands—any damage would be restored. Groundwater contamination will remain on-site for many years or decades; however, installing additional monitoring wells, and developing a long-term monitoring plan and implementing deed restrictions could be accomplished within approximately 6 to 12 months.
Implementability Ability to construct and operate the technology Reliability of the technology Ease of undertaking additional remedial actions, if necessary Ability to monitor effectiveness of remedy Ability to obtain approvals from other agencies Coordination with other agencies Availability of off-site treatment, storage and disposal services and capacity Availability of prospective technologies	Since there is no use of technology proposed, there will be no construction, nothing to operate and no reliability to evaluate. Additional remedial action could be taken. Without monitoring natural degradation processes could not be evaluated. No approvals, coordination or off-site services are required. There are no administrative feasibility issues with this alternative. There are no issues related to service and materials for this alternative since no services and materials are required	This alternative has high technical feasibility since it relies only on sampling (sampling methods are well developed), installation of fencing (which is a standard field task) and additional monitoring wells. Well drillings would produce minimal material for off-site disposal. Undertaking additional remedial action would be easy. Monitoring groundwater and surface water is routinely performed. Enforcement of land use restrictions would require coordination and cooperation with local officials. Restrictions do not appear to conflict with local reuse plans. Coordination with the Towns and the State would be required for the institutional controls, long term monitoring and Site inspections that are part of this alternative. Preparation and recording of the institutional controls will be required. All of the needed services and materials are readily available for this alternative.

Table 5.4-3 Remedial Alternative Cost Estimates	
Remedial Alternative	***Total Cost ($)***
Soil Alternatives	
RA-S1	$0
RA-S2	$118,000
RA-S3	$13,400,000
RA-S4	$10,700,000
RA-S5	$20,900,000
Ground Water Alternatives	
RA-G1	$0
RA-G2	$1,400,000

Table 5.4-4 | **COST ESTIMATE SUMMARY**
RA-S2 COST ESTIMATE
Limited Action (Monitoring and Institutional Controls)

Description	QTY	UNIT	UNIT COST	COST	TOTAL
CAPITAL COSTS					
Site Preparation and General Equipment					$30,000
Repair & replace fencing	500	lf	$8.31	$4,155.99	
Implementation of Deed Restriction	1	ls	$30,000.00	$30,000.00	
				Subtotal Capital Costs:	**$30,000**
Contingencies					$24,375
10% Scope + 15% Bid			25%	$7,500.00	
Project Management			10%	$3,750.00	
Remedial Design			20%	$7,500.00	
Construction Management			15%	$5,625.00	
				Estimated Capital Costs:	**$55,000**
OPERATION, MAINTENANCE, AND MONITORING COSTS					
Five Year Review (Annual Cost)					$3,000
Evaluation of Remedial Action	1	ea	$15,000.00	$15,000.00	
				Subtotal O&M Costs:	**$3,000**
Contingencies					$1,350
10% Scope + 15% Bid			25%	$750.00	
Project Management			6%	$225.00	
O&M Technical Support			10%	$375.00	
				Estimated Annual O&M Costs:	**$5,000**

Cost Type	Years	Annual Cost	Dicount Factor	Present Value
Capital	0	$55,000	1.000	$55,000
O&M	30	$5,000	12.409	$62,045
TOTAL PRESENT VALUE OF ALTERNATIVE:				**$118,000**

Table 5.4-5 **COST ESTIMATE SUMMARY**
RA-S3 COST ESTIMATE
Thermal Desorption of PCP and LNAPL Soils, Stabilization of Arsenic, Consolidation of Contaminated Soils Under Low-Permeability Cover, Off-Site Disposal of Dioxin-Contaminated Soils

Description	QTY	UNIT	UNIT COST	COST	TOTAL
CAPITAL COSTS					
Pre-Mobilization Activities					$748,658
Predesign investigation	1	ls	$200,000.00	$200,000.00	
Permitting/Treatability Study/Interface with regulators	1	ls	$48,657.65	$48,657.65	
Indirect Risk Assessment for Stack Emissions	1	ls	$500,000.00	$500,000.00	
Site Preparation and General Equipment					$854,000
Mobilization/Demobilization (Assume 10%)	1	ls	$33,077.25	$33,077.25	
Temporary office trailer (2)	24	mo	$954.85	$22,916.28	
Temporary storage trailer	24	mo	$125.98	$3,023.58	
Temporary personnel decontamination trailer	24	mo	$477.42	$11,458.14	
Temporary fencing and gates	500	lf	$8.31	$4,155.99	
Construct staging area for mixing/stabilization	1	ls	$10,000.00	$10,000.00	
Portable toilets (3)	24	mo	$285.14	$6,843.42	
Install utility poles	1	ls	$1,000.00	$1,000.00	
Utility connection/disconnection	1	ls	$1,000.00	$1,000.00	
Utilities (phone and electric)	24	mo	$400.00	$9,600.00	
Install erosion control measures	2,000	lf	$3.51	$7,019.49	
Pre-construction survey of railroad tracks	1	ls	$2,500.00	$2,500.00	
Construct vehicle decontamination area	1	ls	$5,000.00	$5,000.00	
Dust monitoring	24	mo	$10,260.65	$246,255.61	
Sheet pile wall excavation support	1,000	sy	$429.12	$429,120.00	
Stabilization equipment mobilization/purchase of components	1	ls	$26,484.50	$26,484.50	
Flagman at railroad crossing	49	days	$700.00	$34,300.00	
Demolition					$551,000
Utility shutoffs	1	ls	$500.00	$500.00	
Asbestos survey	1	ls	$24,600.00	$24,600.00	
Lead paint survey	1	ls	$1,000.00	$1,000.00	
Asbestos abatement and disposal	1	ls	$142,000.00	$142,000.00	
Building demolition - sort/stockpile/controls	300,000	cf	$0.14	$42,000.00	
Concrete slab and foundation removal (steel reinforced)	8,000	sy	$7.85	$62,800.00	
Concrete slab and foundation removal (non-reinforced)	18,000	sy	$0.81	$14,580.00	
Aboveground tank removal & disposal	19	ea	$2,000.00	$38,000.00	
Concrete sump and channel removal	1,000	cy	$2.13	$2,130.00	
Backfill sumps and channels	1,000	cy	$10.29	$10,291.94	
Asphalt removal for excavation in process area	90,000	sf	$0.62	$55,800.00	
Load and transport demolition debris	500	hr	$69.42	$34,710.00	
Disposal of demolition debris	6,000	cy	$20.34	$122,040.00	
Excavation Dewatering					$127,000
Equipment					
Mobilization of base water treatment system	1	ls	$5,000.00	$5,000.00	
Dewatering Pump & Equipment	19	days	$73.94	$1,414.99	
Rental of Base Unit minus carbon	1	mo	$10,302.00	$10,302.00	
Rental of Carbon Equipment & Operation (2 Units)	3	wk	$3,000.00	$9,000.00	
Allowance for optional components	1	mo	$2,500.00	$2,500.00	
Maintenance					
Full time treatment system operator	3	wk	$1,000.00	$3,000.00	
Remove and dispose spent carbon (4,000 lb/mo)	4,000	lb	$1.00	$4,000.00	
Bag filter changeout	3	ea	$288.00	$864.00	
Sand & gravel changeout	3	ea	$1,200.00	$3,600.00	
Monitoring					
Effluent Testing (2 per day, 24-hr TAT)	38	ea	$2,281.50	$87,317.82	
Excavate & Dispose Dioxin-Contaminated Soil					$916,000
Excavate & load dioxin-impacted soil	1,243	cy	$2.55	$3,173.19	
Confirmatory analysis (1 sample every 50 feet)	12	ea	$1,755.00	$21,060.00	
Off-site disposal of dioxin-impacted soil	1,864	ton	$471.00	$878,127.17	
Backfill soil excavation with clean fill	1,243	cy	$10.29	$12,792.12	
Disposal characterization analysis (every 1,000 cy)	2	ea	$395.00	$790.00	

Table 5.4-5 **COST ESTIMATE SUMMARY**
RA-S3 COST ESTIMATE
Thermal Desorption of PCP and LNAPL Soils, Stabilization of Arsenic, Consolidation of Contaminated Soils Under Low-Permeability Cover, Off-Site Disposal of Dioxin-Contaminated Soils

Description	QTY	UNIT	UNIT COST	COST	TOTAL
Ex Situ Thermal Desorption					$4,456,000
Excavate & load SVOC-impacted soil	5,315	cy	$2.55	$13,568.15	
Confirmatory analysis (1 sample every 50 feet)	24	ea	$1,755.00	$42,120.00	
Haul soil to treatment area	5,315	cy	$3.39	$18,008.89	
Excavate clean soil above LNAPL-saturated soil	9,956	cy	$2.55	$25,416.53	
Excavate & load LNAPL-saturated soil	2,478	cy	$2.55	$6,326.33	
Confirmatory analysis (1 sample every 50 feet)	16	ea	$1,125.00	$18,000.00	
Haul soil to treatment area	2,478	cy	$3.39	$8,396.88	
Backfill excavated soil removed from above LNAPL-saturated soil	9,956	cy	$4.72	$46,979.54	
Mobilization/demobilization of mobile process unit	1	ls	$145,475.00	$145,475.00	
Initial emissions stack testing	2	ea	$60,000.00	$120,000.00	
Continuous emissions monitoring	24	day	$2,000.00	$48,000.00	
Process unit rental and operations cost	11,689	ton	$120.95	$1,413,725.07	
LTTD, SVOC Contaminated Soil 500-2,500 tons	11,689	ton	$192.20	$2,246,598.60	
Off-Site Disposal/Incineration of Condensate Water	298	gal	$240.00	$71,536.00	
Off-Site disposal of filter cake	90	ton	$800.00	$71,931.89	
Off-Site disposal treatment system sludge	48	ton	$800.00	$38,723.35	
Backfill excavations with clean fill	7,793	cy	$10.29	$80,200.89	
6" Loam	1,241	cy	$32.02	$39,732.41	
Seed	1.5	acres	$635.92	$978.28	
Excavate and Consolidate Arsenic-Impacted and Treated Soil					$1,163,000
Excavate consolidation area/spoils to side	29,645	cy	$2.55	$75,683.12	
Load, haul and place treated soil in consolidation area	7,793	cy	$8.84	$68,878.82	
Excavate & load arsenic-contaminated soil	21,852	cy	$2.55	$55,788.63	
Confirmatory analysis (1 sample every 50 feet)	48	ea	$1,755.00	$84,240.00	
Haul and place soil in consolidation area	21,852	cy	$7.60	$166,078.74	
Backfill excavation area with clean fill	21,852	cy	$10.29	$224,901.36	
Rental of soil mixer including labor and maintenance	6	mo	$8,238.62	$49,431.74	
Portland Cement (assume 12%)	1,186	cy	$92.00	$109,092.78	
Load soil into mixer (assume one-third fails TCLP testing)	9,882	cy	$1.24	$12,242.45	
Post-stabilization matrix testing (every 500 cubic yards)	23	ea	$708.50	$16,295.50	
Furnish & install 6 inches gas vent sand	4,616	sy	$3.80	$17,539.96	
Furnish & install 40-mil LLDPE geomembrane	4,616	sy	$11.17	$51,558.24	
Furnish & install geocomposite drainage layer	4,616	sy	$8.49	$39,187.95	
Cover with soil removed from consolidation area	29,645	cy	$4.72	$139,891.54	
6" Loam	1,585	cy	$32.02	$50,741.65	
Seed	2.0	acres	$635.92	$1,249.35	
				Subtotal Capital Costs:	**$8,815,658**
Contingencies					$4,297,633
10% Scope + 15% Bid			25%	$2,203,914.41	
Project Management			5%	$550,978.60	
Remedial Design			8%	$881,565.77	
Construction Management			6%	$661,174.32	
				Estimated Capital Costs:	**$13,114,000**

Table 5.4-5 **COST ESTIMATE SUMMARY**
RA-S3 COST ESTIMATE
Thermal Desorption of PCP and LNAPL Soils, Stabilization of Arsenic, Consolidation of Contaminated Soils Under Low-Permeability Cover, Off-Site Disposal of Dioxin-Contaminated Soils

Description	QTY	UNIT	UNIT COST	COST	TOTAL
OPERATION, MAINTENANCE, AND MONITORING COSTS					
Maintain Low Permeability Cover (Annual Cost)					$13,000
Semi-annual inspection of cover	16	hr	$38.43	$614.83	
Mowing	4	ea	$3,000.00	$12,000.00	
Five Year Review (Annual Cost)					$3,000
Evaluation of Remedial Action	1	ea	$15,000.00	$15,000.00	
				Subtotal O&M Costs:	**$16,000**
Contingencies					$7,200
10% Scope + 15% Bid			25%	$4,000.00	
Project Management			6%	$1,200.00	
O&M Technical Support			10%	$2,000.00	
				Estimated Annual O&M Costs:	**$24,000**

Cost Type	Years	Annual Cost	Dicount Factor	Present Value
Capital	0	$13,114,000	1.000	$13,114,000
O&M	30	$24,000	12.409	$297,817
			TOTAL PRESENT VALUE OF ALTERNATIVE:	**$13,412,000**

Table 5.4-6 **COST ESTIMATE SUMMARY**

RA-S4 COST ESTIMATE

Off-Site Disposal of Dioxin and LNAPL Soils, Stabilization of Arsenic, and Consolidation of Contaminated Soils Under Low Permeability Cover

Description	QTY	UNIT	UNIT COST	COST	TOTAL
CAPITAL COSTS					
Pre-Mobilization Activities					$200,000
Predesign investigation	1	ls	$200,000.00	$200,000.00	
Site Preparation and General Equipment					$929,000
Mobilization/Demobilization (Assume 10%)	1	ls	$84,377.70	$84,377.70	
Temporary office trailer (2)	24	mo	$954.85	$22,916.28	
Temporary storage trailer	24	mo	$125.98	$3,023.58	
Temporary personnel decontamination trailer	24	mo	$477.42	$11,458.14	
Temporary fencing and gates	500	lf	$8.31	$4,155.99	
Construct staging area for mixing/stabilization	1	ls	$10,000.00	$10,000.00	
Portable toilets (3)	24	mo	$285.14	$6,843.42	
Install utility poles	1	ls	$1,000.00	$1,000.00	
Utility connection/disconnection	1	ls	$1,000.00	$1,000.00	
Utilities (phone and electric)	24	mo	$400.00	$9,600.00	
Install erosion control measures	2,000	lf	$3.51	$7,019.49	
Pre-construction survey of railroad tracks	1	ls	$2,500.00	$2,500.00	
Construct vehicle decontamination area	1	ls	$5,000.00	$5,000.00	
Dust monitoring	24	mo	$10,260.65	$246,255.61	
Sheet pile wall excavation support	1,000	sy	$429.12	$429,120.00	
Stabilization equipment mobilization/purchase of components	1	ls	$26,484.50	$26,484.50	
Flagman at railroad crossing	82	days	$700.00	$57,400.00	
Demolition					$551,000
Utility shutoffs	1	ls	$500.00	$500.00	
Asbestos survey	1	ls	$24,600.00	$24,600.00	
Lead paint survey	1	ls	$1,000.00	$1,000.00	
Asbestos abatement and disposal	1	ls	$142,000.00	$142,000.00	
Building demolition - sort/stockpile/controls	300,000	cf	$0.14	$42,000.00	
Concrete slab and foundation removal (steel reinforced)	8,000	sy	$7.85	$62,800.00	
Concrete slab and foundation removal (non-reinforced)	18,000	sy	$0.81	$14,580.00	
Aboveground tank removal & disposal	19	ea	$2,000.00	$38,000.00	
Concrete sump and channel removal	1,000	cy	$2.13	$2,130.00	
Backfill sumps and channels	1,000	cy	$10.29	$10,291.94	
Asphalt removal for excavation in process area	90,000	sf	$0.62	$55,800.00	
Load and transport demolition debris	500	hr	$69.42	$34,710.00	
Disposal of demolition debris	6,000	cy	$20.34	$122,040.00	
Excavation Dewatering					$127,000
Equipment					
Mobilization of base water treatment system	1	ls	$5,000.00	$5,000.00	
Dewatering Pump & Equipment	19	days	$73.94	$1,414.99	
Rental of Base Unit minus carbon	1	mo	$10,302.00	$10,302.00	
Rental of Carbon Equipment & Operation (2 Units)	3	wk	$3,000.00	$9,000.00	
Allowance for optional components	1	mo	$2,500.00	$2,500.00	
Maintenance					
Full time treatment system operator	3	wk	$1,000.00	$3,000.00	
Remove and dispose spent carbon (4,000 lb/mo)	4,000	lb	$1.00	$4,000.00	
Bag filter changeout	3	ea	$288.00	$864.00	
Sand & gravel changeout	3	ea	$1,200.00	$3,600.00	
Monitoring					
Effluent Testing (2 per day, 24-hr TAT)	38	ea	$2,281.50	$87,317.82	
Dioxin/LNAPL-Saturated Soil - Hot Spot Removal					$4,013,000
Excavate & load dioxin-impacted soil	1,243	cy	$2.55	$3,173.19	
Confirmatory analysis (1 sample every 50 feet)	12	ea	$1,755.00	$21,060.00	
Off-site disposal of dioxin-impacted soil	1,864	ton	$471.00	$878,127.17	
Backfill soil excavation with clean fill	1,243	cy	$10.29	$12,792.12	
Excavate clean soil above LNAPL-saturated soil	9,956	cy	$2.55	$25,416.53	
Excavate & load LNAPL-saturated soil	2,478	cy	$2.55	$6,326.33	
Confirmatory analysis (1 sample every 50 feet)	16	ea	$1,125.00	$18,000.00	

Table 5.4-6 **COST ESTIMATE SUMMARY**
RA-S4 COST ESTIMATE
Off-Site Disposal of Dioxin and LNAPL Soils, Stabilization of Arsenic, and Consolidation of Contaminated Soils Under Low Permeability Cover

Description	QTY	UNIT	UNIT COST	COST	TOTAL
Off-site disposal of oil-saturated soil	3,717	ton	$800.00	$2,973,600.00	
Backfill excavated soil removed from above LNAPL-saturated soil	9,956	cy	$4.72	$46,979.54	
Backfill soil excavation with clean fill	2,478	cy	$10.29	$25,503.42	
Disposal characterization analysis (every 1,000 cy)	4	ea	$395.00	$1,580.00	
Excavate and Consolidate Arsenic-Impacted Soil					$1,188,000
Excavate consolidation area/spoils to side	27,167	cy	$2.55	$69,356.78	
Excavate & load arsenic-contaminated soil	27,167	cy	$2.55	$69,356.78	
Confirmatory analysis (1 sample every 50 feet)	56	ea	$1,755.00	$98,280.00	
Haul and place soil in consolidation area	27,167	cy	$7.60	$206,470.16	
Backfill excavation area with clean fill	27,167	cy	$10.29	$279,598.82	
Rental of soil mixer including labor and maintenance	6	mo	$8,238.62	$49,431.74	
Portland Cement (assume 12%)	1,087	cy	$92.00	$99,973.74	
Load soil into mixer (assume one-third fails TCLP testing)	9,056	cy	$1.24	$11,219.11	
Post-stabilization matrix testing (every 500 cubic yards)	21	ea	$708.50	$14,878.50	
Furnish & install 6 inches gas vent sand	4,616	sy	$3.80	$17,539.96	
Furnish & install 40-mil LLDPE geomembrane	4,616	sy	$11.17	$51,558.24	
Furnish & install geocomposite drainage layer	4,616	sy	$8.49	$39,187.95	
Cover with soil removed from consolidation area	27,167	cy	$4.72	$128,198.04	
6" Loam	1,585	cy	$32.02	$50,741.65	
Seed	2.0	acres	$635.92	$1,249.35	
				Subtotal Capital Costs:	**$7,008,000**
Contingencies					$3,416,400
10% Scope + 15% Bid			25%	$1,752,000.00	
Project Management			5%	$438,000.00	
Remedial Design			8%	$700,800.00	
Construction Management			6%	$525,600.00	
				Estimated Capital Costs:	**$10,425,000**

OPERATION, MAINTENANCE, AND MONITORING COSTS

Description	QTY	UNIT	UNIT COST	COST	TOTAL
Maintain Low Permeability (Annual Cost)					$13,000
Semi-annual inspection of cover	16	hr	$38.43	$614.83	
Mowing	4	ea	$3,000.00	$12,000.00	
Five Year Review (Annual Cost)					$3,000
Evaluation of Remedial Action	1	ea	$15,000.00	$15,000.00	
				Subtotal O&M Costs:	**$16,000**
Contingencies					$7,200
10% Scope + 15% Bid			25%	$4,000.00	
Project Management			6%	$1,200.00	
O&M Technical Support			10%	$2,000.00	
				Estimated Annual O&M Costs:	**$24,000**

Cost Type	Years	Annual Cost	Dicount Factor	Present Value
Capital	0	$10,425,000	1.000	$10,425,000
O&M	30	$24,000	12.409	$297,817

TOTAL PRESENT VALUE OF ALTERNATIVE: $10,723,000

Table 5.4-7 **COST ESTIMATE SUMMARY**
RA-S5 COST ESTIMATE
Excavation and Off-Site Disposal

Description	QTY	UNIT	UNIT COST	COST	TOTAL
CAPITAL COSTS					
Site Preparation and General Equipment					$898,000
Mobilization/Demobilization (Assume 10%)	1	ls	$33,077.25	$33,077.25	
Temporary office trailer (2)	24	mo	$954.85	$22,916.28	
Temporary storage trailer	24	mo	$125.98	$3,023.58	
Temporary personnel decontamination trailer	24	mo	$477.42	$11,458.14	
Temporary fencing and gates	500	lf	$8.31	$4,155.99	
Construct staging area for mixing/stabilization	1	ls	$10,000.00	$10,000.00	
Portable toilets (3)	24	mo	$285.14	$6,843.42	
Install utility poles	1	ls	$1,000.00	$1,000.00	
Utility connection/disconnection	1	ls	$1,000.00	$1,000.00	
Utilities (phone and electric)	24	mo	$400.00	$9,600.00	
Install erosion control measures	2,000	lf	$3.51	$7,019.49	
Pre-construction survey of railroad tracks	1	ls	$2,500.00	$2,500.00	
Construct vehicle decontamination area	1	ls	$5,000.00	$5,000.00	
Dust monitoring	24	mo	$10,260.65	$246,255.61	
Sheet pile wall excavation support	1,000	sy	$429.12	$429,120.00	
Stabilization equipment mobilization/purchase of components	1	ls	$26,484.50	$26,484.50	
Flagman at railroad crossing	112	days	$700.00	$78,400.00	
Demolition					$551,000
Utility shutoffs	1	ls	$500.00	$500.00	
Asbestos survey	1	ls	$24,600.00	$24,600.00	
Lead paint survey	1	ls	$1,000.00	$1,000.00	
Asbestos abatement and disposal	1	ls	$142,000.00	$142,000.00	
Building demolition - sort/stockpile/controls	300,000	cf	$0.14	$42,000.00	
Concrete slab and foundation removal (steel reinforced)	8,000	sy	$7.85	$62,800.00	
Concrete slab and foundation removal (non-reinforced)	18,000	sy	$0.81	$14,580.00	
Aboveground tank removal & disposal	19	ea	$2,000.00	$38,000.00	
Concrete sump and channel removal	1,000	cy	$2.13	$2,130.00	
Backfill sumps and channels	1,000	cy	$10.29	$10,291.94	
Asphalt removal for excavation in process area	90,000	sf	$0.62	$55,800.00	
Load and transport demolition debris	500	hr	$69.42	$34,710.00	
Disposal of demolition debris	6,000	cy	$20.34	$122,040.00	
Excavation Dewatering					$127,000
Equipment					
Mobilization of base water treatment system	1	ls	$5,000.00	$5,000.00	
Dewatering Pump & Equipment	19	days	$73.94	$1,414.99	
Rental of Base Unit minus carbon	1	mo	$10,302.00	$10,302.00	
Rental of Carbon Equipment & Operation (2 Units)	3	wk	$3,000.00	$9,000.00	
Allowance for optional components	1	mo	$2,500.00	$2,500.00	
Maintenance					
Full time treatment system operator	3	wk	$1,000.00	$3,000.00	
Remove and dispose spent carbon (4,000 lb/mo)	4,000	lb	$1.00	$4,000.00	
Bag filter changeout	3	ea	$288.00	$864.00	
Sand & gravel changeout	3	ea	$1,200.00	$3,600.00	
Monitoring					
Effluent Testing (2 per day, 24-hr TAT)	38	ea	$2,281.50	$87,317.82	
Excavation and Disposal of Contaminated Soil and Sediment					$12,648,000
Excavate & load dioxin-impacted soil	1,243	cy	$2.55	$3,173.19	
Confirmatory analysis (1 sample every 50 feet)	12	ea	$1,755.00	$21,060.00	
Off-site disposal of dioxin-impacted soil	1,864	ton	$471.00	$878,127.17	
Backfill soil excavation with clean fill	1,243	cy	$10.29	$12,792.12	
Excavate clean soil above LNAPL-saturated soil	9,956	cy	$2.55	$25,416.53	
Excavate & load LNAPL-saturated soil	2,478	cy	$2.55	$6,326.33	
Confirmatory analysis (1 sample every 50 feet)	16	ea	$1,125.00	$18,000.00	
Off-site disposal of oil-saturated soil	3,717	ton	$800.00	$2,973,600.00	
Backfill excavated soil removed from above LNAPL-saturated soil	9,956	cy	$4.72	$46,979.54	
Backfill soil excavation with clean fill	2,478	cy	$10.29	$25,503.42	
Excavate & load arsenic-contaminated soil	21,852	cy	$2.55	$55,788.63	

Table 5.4-7
RA-S5 COST ESTIMATE
Excavation and Off-Site Disposal

COST ESTIMATE SUMMARY

Description	QTY	UNIT	UNIT COST	COST	TOTAL
Confirmatory analysis (1 sample every 50 feet)	48	ea	$1,755.00	$84,240.00	
Off-site disposal of arsenic-contaminated soil	21,852	cy	$250.00	$5,463,046.30	
Backfill soil excavation with clean fill	21,852	cy	$10.29	$224,901.36	
Excavate & load mixed arsenic/PCP-contaminated soil	5,315	cy	$2.55	$13,568.15	
Confirmatory analysis (1 sample every 50 feet)	24	ea	$1,755.00	$42,120.00	
Off-site disposal of mixed arsenic/PCP-contaminated soil	5,315	cy	$471.00	$2,503,173.11	
Backfill soil excavation with clean fill	5,315	cy	$10.29	$54,697.46	
Disposal characterization analysis (every 1,000 cy)	31	ea	$395.00	$12,245.00	
6" Loam	5,556	cy	$32.02	$177,874.46	
Seed	7	acres	$635.92	$4,379.59	
				Subtotal Capital Costs:	**$14,224,000**
Contingencies					$6,578,600
10% Scope + 15% Bid			25%	$3,556,000.00	
Project Management			5%	$889,000.00	
Remedial Design			6%	$1,066,800.00	
Construction Management			6%	$1,066,800.00	
				Estimated Capital Costs:	**$20,803,000**

OPERATION, MAINTENANCE, AND MONITORING COSTS

Description	QTY	UNIT	UNIT COST	COST	TOTAL
Inspection and Maintenance (Annual Cost)					$1,000
Semi-annual inspection	8	hr	$38.43	$307.41	
Five Year Review (Annual Cost)					$3,000
Evaluation of Remedial Action	1	ea	$15,000.00	$15,000.00	
				Subtotal O&M Costs:	**$4,000**
Contingencies					$1,800
10% Scope + 15% Bid			25%	$1,000.00	
Project Management			6%	$300.00	
O&M Technical Support			10%	$500.00	
				Estimated Annual O&M Costs:	**$6,000**

Cost Type	Years	Annual Cost	Dicount Factor	Present Value
Capital	0	$20,803,000	1.000	$20,803,000
O&M	30	$6,000	12.409	$74,454

TOTAL PRESENT VALUE OF ALTERNATIVE: $20,878,000

Table 5.4-8 **COST ESTIMATE SUMMARY**
RA-G2 COST ESTIMATE
Limited Action (Monitoring and Institutional Controls)

Description	QTY	UNIT	UNIT COST	COST	TOTAL
CAPITAL COSTS					
Installation of New Monitoring Wells					$28,000
Install overburden monitoring wells	12	ea	$1,950.00	$23,400.00	
Supervision	12	days	$307.41	$3,688.98	
				Subtotal Capital Costs:	**$28,000**
Contingencies					$22,750
10% Scope + 15% Bid			25%	$7,000.00	
Project Management			10%	$3,500.00	
Remedial Design			20%	$7,000.00	
Construction Management			15%	$5,250.00	
				Estimated Capital Costs:	**$51,000**
OPERATION, MAINTENANCE, AND MONITORING COSTS					
Semi-Annual Sampling (Annual Cost)					$72,000
Semi-annual inspection of site, river and monitoring wells	16	hr	$38.43	$614.83	
Collection of Ground water and surface water samples	16	days	$307.41	$4,918.63	
Ground Water Sample Analysis (15 wells x 2 rounds per yr)	30	ea	$1,124.50	$33,735.00	
Surface Water Sample Analysis	12	ea	$1,014.00	$12,168.00	
Semi-annual sampling report	2	ea	$10,000.00	$20,000.00	
Additional Cost to Site Five Year Review (Annual Cost)					$3,000
Evaluation of Remedial Action	1	ea	$15,000.00	$15,000.00	
				Subtotal O&M Costs:	**$75,000**
Contingencies					$33,750
10% Scope + 15% Bid			25%	$18,750.00	
Project Management			6%	$5,625.00	
O&M Technical Support			10%	$9,375.00	
				Estimated Annual O&M Costs:	**$109,000**

Cost Type	Years	Annual Cost	Dicount Factor	Present Value
Capital	0	$51,000	1.000	$51,000
O&M	30	$109,000	12.409	$1,352,585

TOTAL PRESENT VALUE OF ALTERNATIVE: $1,404,000

Table 5.5-1: Chemical Specific ARARs					
Alternative	**Media/ Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to Attain ARAR**
	All Media				
Applies to all alternatives*	Federal Criteria, Advisories, and Guidance	American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs)	To Be Considered	Health-based guidelines for exposure limit represented in terms of exposure over a workday (8 hours) or a work week (40 hours). These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs will be used for assessing site inhalation risks for site remediation workers.
Applies to all alternatives*		EPA Risk Reference Dose (RfDs) and EPA Carcinogen Assessment Group Potency Factors	To Be Considered	Reference dose is an estimate of a daily oral exposure to human populations that is likely to be without an appreciable risk of non-cancer effects. The Cancer Group Potency Factors are used as qualitative weight-of-evidence judgment as to the likelihood of a chemical being a carcinogen.	Risks due to carcinogens and noncarcinogens with EPA RfDs and carcinogens with Cancer Potency Factors were used to develop target cleanup levels and evaluate remedial alternatives.
Applies to all alternatives*		EPA Carcinogenicity Slope Factors	To Be Considered	Slope factors are developed by EPA from health effects assessments. Carcinogenic effects present the most up-to-date information on cancer risk.	Risks due to carcinogens as assessed with slope factors were used to develop target cleanup levels and evaluate remedial alternatives.
Applies to all alternatives*		OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils	To Be Considered	This draft guidance establishes a methodology for assessing indoor air risks to human health.	Risks associated with future residential exposure to indoor air were evaluated consistent with this guidance.
Applies to RA-S3, RA-S4 and RA-S5		US EPA Guidance: Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites	To Be Considered	Recommends PRG's or points of departure for cleanup levels for dioxin in soils and sediments at CERCLA sites. Recommended cleanup levels are based on direct exposure pathway.	This guidance was used in setting cleanup levels for dioxin-contaminated soils.

Table 5.5-1: Chemical Specific ARARs					
Alternative	**Media/ Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to Attain ARAR**
Applies to all alternatives*	Other guidance	Ontario Ministry of Environment and Energy (OMEE) Lowest and Severe Effect Levels (LELs and SELs) for Freshwater Sediments (Persaud et al. 1993)	To be considered	The LEL value is the concentration at which the majority of the sediment-dwelling organisms are not affected.	The LEL value was used for selecting Chemicals of Potential Concern and for characterizing ecological effects for all alternatives and to assist in setting soil/sediment cleanup levels.
Applies to all alternatives*+	State Regulatory Requirements	Massachusetts Ground Water Quality Standards (314 CMR §6.00)	Applicable	Establishes groundwater quality criteria necessary to sustain the designated uses, and regulations necessary to achieve the designated uses or maintain the existing groundwater quality. Groundwater at the site is classified as Class II and III, non-potable uses.	Excavation and monitoring activities will ensure that contaminants in groundwater do not cause indoor air inhalation risks or cause surface water to be degraded above AWQC. (see 314 CMR§6.06(3))

*Because alternatives RA-S1 and RA G1 do no require any action to be taken, this requirement is used to assist in determining a baseline risk.

+Alternatives RA-S1 and RA-G1 rely on natural processes to address risk at the Site in conjunction with monitoring and institutional controls.

Table 5.5-2: Location-Specific ARARs					
Alternative	**Media/ Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to Attain ARAR**
	All Media				
Applies to RA-S2 (monitoring) RA-S3, RA-S4, RA-S5, RA-G2		Executive Order 11990; "Protection of Wetlands" (40 CFR Part 6, Appendix A)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Action to avoid, whenever possible, the long- and short-term impacts on wetlands and to preserve and enhance wetlands. If activity takes place, impacts must be minimized to the maximum extent.	Wetlands have been identified on the site and excavation, consolidation and installation of monitoring wells occur in or around wetlands. Because high levels of contamination exist in or near wetlands areas, there is no practicable alternative to excavating or consolidating in these areas. All practicable means will be used to minimize harm to the wetlands. Wetlands disturbed by remedial activities will be mitigated, restored, or preserved. The Proposed Plan will solicit specific comments on this work.
Applies to RA-S3, RA-S4, and RA-S5		Fish and Wildlife Coordination Act (16 U.S.C. §661 et seq.); Fish and wildlife protection (40 CFR §6.302(g))	Applicable	Any modification of a body of water requires consultation with the U.S. Fish and Wildlife Services and the appropriate state wildlife agency to develop measures to prevent,, mitigate or compensate for losses of fish and wildlife.	The Site includes streams and rivers. These alternatives may require discharge of treated water into Rumford River resulting from dewatering activities.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		Executive Order 11988; "Floodplain Management" (40 CFR Part 6, Appendix A)	Applicable	Actions will avoid, whenever possible, the long- and short-term impacts associated with the occupancy and modifications of floodplains development, wherever there is a practical alternative. Promotes the preservation and restoration of floodplains so that their natural and beneficial value can be realized.	The Site includes areas defined to be within the 100-year floodplain. These alternatives all involve installation of monitoring wells; some include excavation, and/or consolidation and cap construction possibly in the floodplain areas. All practicable means will be followed to minimize harm and avoid adverse effects as much as possible. Actions will be taken to restore and preserve the natural and beneficial values of the floodplain.
Applies to RA-S3, RA-S4,	Federal Regulatory Requirements (continued)	Standards For Owners And Operators Of RCRA Hazardous Waste Treatment, Storage, And Disposal Facilities, 40 C.F.R. Part 264.18(b)k General	Applicable	Requires that hazardous waste treatment, storage, or disposal facilities within a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout unless an alternative demonstration	The Site includes areas defined to be within the 100-year floodplain. Consolidation and capping will be designed, constructed and maintained to prevent washout by a 100-year flood.

Table 5.5-2: Location-Specific ARARs					
Alternative	**Media/ Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to Attain ARAR**
		Facility Standards, Subpart B		is made to the Regional Administrator.	
Applies to RA-S2 , RA-S3, RA-S4,. RA-S5, RA-G2		Endangered Species Act, 16 U.S.C. 1531 et seq.; 50 C.F.R. Parts 17.11-12	Applicable	Requires site action to be conducted in a manner that avoids harming threatened or endangered species or their habitat.	Transient bald eagles have been sited. Work will be conducted to avoid harming the bald eagle or its habitat.
Applies to RA-S2 , RA-S3, RA-S4,. RA-S5, RA-G2	State Regulatory Requirements	Wetlands Protection Act (Mass. Gen. Laws ch. 131, §40); Wetlands Protection Regulations (310 CMR §10.00)	Applicable	Sets performance standards for dredging, filling, altering of inland wetlands and within 100 feet of a wetland. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Resource areas at the site covered by the regulations include banks, bordering vegetated wetlands, land under bodies of water, land subject to flooding, riverfront, and estimated habitats of rare wildlife. Under this requirement available alternatives must be considered that minimize the extent of adverse impacts and mitigation including restoration and/or replication are required.	Wetlands have been identified on the site and excavation, consolidation and installation of monitoring wells occur in or around wetlands and the 100 foot buffer zone. Because high levels of contamination exist in or near wetlands areas, there is no practicable alternative to excavating or consolidating in these areas. All practicable means will be used to minimize harm to the wetlands including erosion and sedimentation controls and stormwater management. Wetlands disturbed by remedial activities will be mitigated, restored, or preserved.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, and RA-G2		Massachusetts Endangered Species Act (Mass. Gen. Laws ch. 131, §40); Massachusetts Endangered Species Act Regulations, Part III: Alteration of Significant Habitat (321 CMR §§10.30-10.43)	Applicable	The MESA establishes State's list of threatened and endangered species and species of special concern. Habitat of such species is protected by the regulations promulgated under the MA Wetlands Protection Act.	The Site is noted as being near the habitat of "species of special concern" (see letter in Appendix B); further review will be conducted to determine applicability of this requirement. Should endangered or threatened species or species of special concern be determined to be present at the site, the substantive requirements of this regulation will be met.

Table 5.5-2: Location-Specific ARARs					
Alternative	**Media/ Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to Attain ARAR**
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2	Federal Criteria, Advisories and Guidance	Policy on Floodplains and Wetland Assessments for CERCLA Actions (EPA OSWER, 8/8/1985)	To Be Considered	Floodplain and wetlands assessments must be incorporated into analysis conducted during planning of remedial action; public participation requirements must also be met. Restates requirement that remedial action may only be located in wetlands if no practicable alternative exists. Potential harm or adverse effects to wetlands or floodplains must be minimized and/or mitigated as required by law/regulation.	Floodplain and wetlands assessments and associated considerations were incorporated into RI/FS process. Public participation requirements will be met through Proposed Plan. Substantive requirements for decision-making will be met when selecting and designing remedy.

Table 5.5-3: Action-Specific ARARS					
Alternative	**Media/Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to be Taken to Attain ARAR**
	Surface Water, Wetlands				
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2	Federal Regulatory Requirements	Clean Water Act (33 U.S.C. §1251 *et seq*.); Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR Part 230, 231 and 33 CFR Parts 320-323)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. Controls discharges of dredged or fill material to protect aquatic ecosystems.	Wetlands have been identified on the site coincident with contamination. Excavation, consolidation, and installation of monitoring wells will occur in and around site wetlands. These actions will be designed to minimize adverse effects and to preserve, mitigate, and restore disturbed areas.
Applies to RA-S3, RA-S4		Rivers and Harbors Act of 1899 (33 U.S.C. §401 *et seq*.); (33 CFR Part 320)	Applicable	Protects navigable rivers from unauthorized discharges or from unauthorized obstruction or alteration.	Discharges to the Rumford River resulting from dewatering activities, if any, will occur via a piping system that will not obstruction or alter the River.
Applies to RA-S-3, RA-S4, RA-S5		Clean Water Act, Section 402, National Pollutant Discharge Elimination System (NPDES), 33 USC 1342 (40 CFR 122-125, 131)	Applicable	These standards govern discharge of water into surface waters.	Groundwater resulting from dewatering activities, if any, will be treated to the required standards before discharge to the Rumford River.
Applies to RA-S3, RA-S4, RA-S5	State Regulatory Requirements	Massachusetts Surface Water Quality Standards—Vernal Pools, 314 CMR '4.06(1)(d)(11) and 314 CMR 9.08 (variance)	Relevant and Appropriate	Prohibits discharge of dredged or fill material to a vernal pool certified by the Massachusetts of Division of Fisheries and Wildlife, unless a variance is granted under 314 CMR 9.08.)(11) – Vernal Pools	Wetland features exist, although not officially classified, may be characteristic of vernal pools. If further studies indicate an ecological risk exists, it will be considered an overriding public interest to address the risk. Dredging and/or filling activities will be conducted to avoid, minimize and mitigate adverse effects and restoration/replication will be conducted.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		Surface Water Quality Standards (314 CMR 4.00)	Applicable	Surface water in the vicinity of the Site are classified as Class B and designated as habitat for fish, other aquatic and wildlife, and for primary and secondary contact recreation. The state surface water minimum criteria	Surface water standards will be used as performance criteria to measure the effectiveness of the Site remedy to prevent degradation of surface water below these standards.

Table 5.5-3: Action-Specific ARARS					
Alternative	**Media/Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to be Taken to Attain ARAR**
				for Class B waters are consistent with federal AWQC.	
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		401 Water Quality Certification for Discharge of Dredged or Fill Material, 314 CMR 9.00	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, adverse impacts must be minimized. Controls discharges of dredged or fill material to protect aquatic ecosystems.	Wetlands have been identified on the site coincident with contamination. Excavation, consolidation, and installation of monitoring wells will occur in and around site wetlands. These actions will be designed to minimize adverse effects and to preserve, mitigate, and restore disturbed areas.
Applies to RA-S-3, RA-S4, RA-S5		Massachusetts DEP Surface Water Discharge Permit Program (314 CMR 3)	Applicable	These standards govern discharge of water into surface waters.	Groundwater resulting from dewatering activities, if any, will be treated to the required standards before discharge to the Rumford River.
	Groundwater				
Applies to RA-S2, RA-S3, RA-S4, RA-S5 and RA-G2	Federal Regulatory Requirements	Federal Safe Drinking Water Act – Maximum Contaminant Levels (MCLs) and non-zero MCLs 40 CFR 141	Relevant and Appropriate	These levels regulate the concentration of contaminants in public drinking water supplies but may also be considered appropriate for groundwater aquifers potentially used for drinking water.	These standards will be used during groundwater monitoring to measure the performance of the remedy to ensure that groundwater migrating off the Site does not exceed MCLs and non-zero MCLs.
Applies to RA-S2, RA-S3, RA-S4, RA-S5 and RA-G2		Resource Conservation and Recovery Act (42 U.S.C. §6901 et seq.); (40 CFR 264.94 and 95) Subpart F	Relevant and Appropriate	Establishes maximum concentration limits for RCRA groundwater monitoring and response requirements for solid waste management units. Standards for 14 toxic compounds have been adopted as part of RCRA groundwater protection standards.	These standards will be used during groundwater monitoring to measure the performance of the remedy to ensure that groundwater migrating off the Site does not exceed RCRA groundwater concentration levels for Site contaminants. Compliance boundary is south of the Rumford River and will be established more specifically during remedial design.

Table 5.5-3: Action-Specific ARARS					
Alternative	**Media/Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to be Taken to Attain ARAR**
Applies to RA-S2, RA-S3, RA-S4, RA-S5 and RA-G2		Resource Conservation and Recovery Act (42 U.S.C. §6901 et seq.); (40 CFR 264.100) Subpart F	Relevant and Appropriate	Requires that corrective action be taken in the event groundwater is migrating offsite in excess of RCRA groundwater concentration levels set out in 40 CFR 264.94.	Corrective action will be taken should offsite monitoring wells demonstrate that groundwater is migrating offsite in excess of RCRA groundwater concentration levels.
Applies to RA-S2, RA-S3, RA-S4, RA-S5 and RA-G2	State Regulatory Requirements	Massachusetts DEP Drinking Water Standards, 310 CMR 22.00	Relevant and Appropriate	These levels regulate the concentration of contaminants in public drinking water supplies but may also be considered appropriate for groundwater aquifers potentially used for drinking water.	These standards will be used during groundwater monitoring to measure the performance of the remedy to ensure that groundwater migrating off the Site does not exceed MCLs and non-zero MCLs that are more stringent that federal standards for Site contaminants.
	<u>**Air**</u>				
Applies to RA-S3, RA-S4 and RA-S5	Federal Regulatory Requirements	National Emission Standards for Hazardous Air Pollutants (NESHAPs) 40 CFR Part 61 Subparts H&I	Relevant and Appropriate	Regulates air emissions of VOC's from regulated source categories.	VOC emission levels will be met during soil treatment processes through carbon filtering and/or other engineering controls
Applies to RA-S3, RA-S4, RA-S5		RCRA Air Emissions Standards for Process Vents (40 CFR Part 264, Subpart AA)	Relevant and Appropriate if threshold concentrations are met	Contains air pollutant emission standards applying to solvent extraction and air stripping facilities that treat RCRA wastes with total organics concentrations of 10 parts per million by weight or greater.	Treatment components treating wastes with regulated levels of organic constituents will be designed to meet the criteria set forth in this subpart if threshold levels are met.
Applies to RA-S3, RA-S4, RA-S5		RCRA Air Emissions Standards for Equipment Leaks (40 CFR Part 264, Subpart BB)	Relevant and Appropriate if treatment involves groundwater with organics at concentrations of at least 10% by weight.	Sets emission standards for equipment that contains or contacts RCRA wastes with organic concentrations of at least 10 percent by weight.	Treatment components treating wastes with regulated levels of VOCs will be designed to meet the criteria set forth in this subpart if threshold levels are met.

Table 5.5-3: Action-Specific ARARS					
Alternative	**Media/Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to be Taken to Attain ARAR**
Applies to RA-S3, RA-S4, RA-S5		RCRA Air Emissions Standards for Tanks and containers (40 CFR Part 264, Subpart CC)	Relevant and Appropriate if threshold levels are met	Requires specific organic emissions controls on tanks and containers having VOC concentrations equal to or greater than 500 parts per million by weight.	Treatment facility components treating wastes with regulated levels of VOCs will be designed to meet the criteria set forth in this subpart if threshold levels are met.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2	State Regulatory Requirements	Ambient Air Quality Standards (310 CMR 6.00)	Applicable	Sets primary and secondary standards for emissions of Sulfur Oxides, particulate matter, CO, ozone, Nitrogen Dioxide, and Lead.	Remedies will be designed, constructed, and operated in accordance with these rules. No air emissions from remedial treatment will cause ambient air quality standards to be exceeded. Dust standards will be complied with during any and all excavation of materials at the Site.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		Massachusetts DEP Air Pollution Control Regulations (310 CMR 7.00)	Applicable	Regulates dust, particulates and fugitive emissions. Establishes emissions limitations for various processes and regions within the state.	Excavation and treatment processes will be designed, constructed, and operated in accordance with these rules. Air monitoring will be conducted to ensure levels are met.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, and RA-G2	Massachusetts Criteria, Advisories, and Guidance	Massachusetts Threshold Effects Exposure Levels (TELs) and Allowable Ambient Limits (AALs) for Air (December 1995)	To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	Evaluation of air emissions will consider AALs and TEL's.
	Soil				
	Federal Regulatory Requirements Base RCRA program has been delegated to Massachusetts; therefore, only State references appear as ARARs unless particular provision not contained in State program.				

Table 5.5-3: Action-Specific ARARS					
Alternative	**Media/Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to be Taken to Attain ARAR**
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2	State Regulatory Requirements	RCRA Hazardous Waste Management - Identification and Listing of Hazardous Waste (310 CMR 30.100)	Applicable	Establishes standards for identifying and listing hazardous waste.	Testing as appropriate will assess whether hazardous wastes are present in excavated soil, sediments (if any) and groundwater generated during remedial activities.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		Hazardous Waste Management - Requirements for Generators of Hazardous Waste (310 CMR 30.300)	Applicable to any action that generates hazardous waste	Generator requirements outline waste characterization, management of containers, packaging, labeling, and manifesting. Generator requirements apply to contaminated substances meeting the definition of hazardous under 310 CMR 100.	Waste generated during excavation, treatment processes and well drilling that are characteristic waste will be managed in accordance with the substantive requirements of this regulation
Applies to RA-S3, RA-S4		Hazardous Waste Management – Landfill Closure and Post Closure Care (310 CMR 30.633 (1)(a-d), 2(a), (d), (e))	Relevant and Appropriate	Establishes performance standards for low permeability covers and for post closure care and for groundwater monitoring.	Consolidated wasted will be covered onsite with a low permeability cover that meets these standards. Post-closure care of cover will meet these standards.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		Hazardous Waste Management – Closure and Post Closure (310 CMR 30.582, 30.585, 30.592)	Relevant and Appropriate	Establishes performance standards for closure and pose closure care and groundwater monitoring	All equipment, structures and soil will be properly decontaminated and disposed of during the remedial action. Post closure care will meet substantive standards as determined by EPA.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		Hazardous Waste Management – General Requirements for ignitable, reactive, or incompatible waste (310 CMR 30.560)	Applicable	General requirement for handling hazardous waste.	Hazardous wastes will be handled in accordance with these requirements.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		Hazardous Waste Management – Tanks (310 CMR 30.343)	Applicable	Establishes management procedures tanks uses to store hazardous waste.	Any hazardous waste stored in containers will meet substantive requirements of this subpart, including condition and management of containers.
Applies to RA-S2, RA-S3, RA-S4, RA-S5, RA-G2		Hazardous Waste Management - Containers (310 CMR 30.342)	Applicable	Specifies conditions under which hazardous waste may be stored in containers.	Any hazardous waste stored in containers will meet substantive requirements of this subpart, including condition and management of containers.

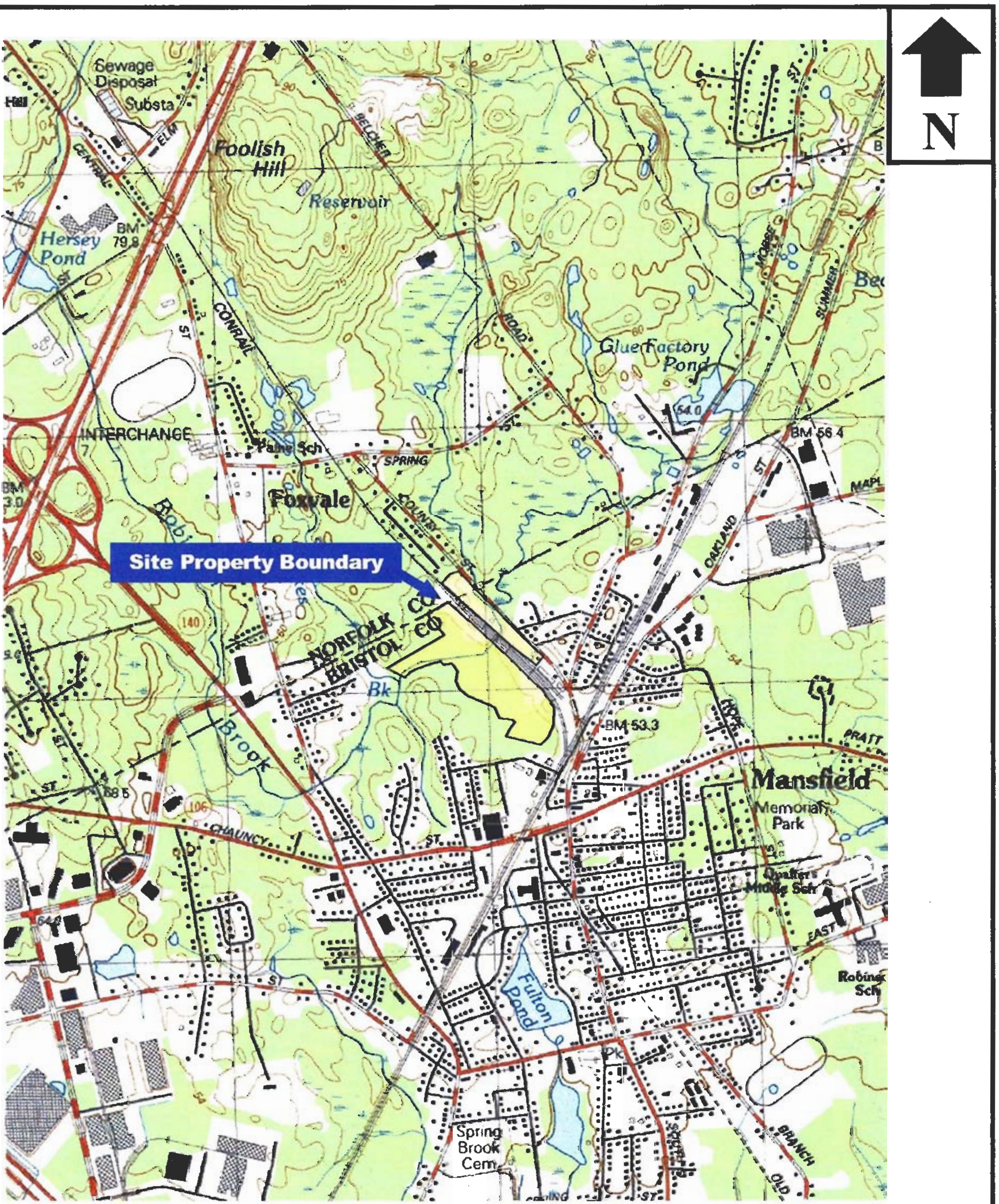
Table 5.5-3: Action-Specific ARARS					
Alternative	**Media/Authority**	**Requirements**	**Status**	**Requirement Synopsis**	**Action to be Taken to Attain ARAR**
Applies to RA-S3 and RA-S4	Federal Criteria, Advisories and Guidance	Revised Alternative Cap Design Guidance Proposed for Unlined, Hazardous Waste Landfills in the EPA Region I (EPA OSRR, 2/5/01).	To Be Considered	Provides guidance for landfill cap design for unlined, hazardous waste landfills at Superfund landfill sites in EPA Region I.	Guidance will be considered when designing low permeability cover for consolidated material onsite.
Policy on Floodplains and Wetland Assessments for CERCLA Actions (EPA OSWER, 8/8/1985)		USEPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments (EPA/530-SW-89-047)	To Be Considered	Presents technical specifications for the design of multi-barrier covers for landfills at which hazardous wastes were disposed.	Technical specifications in guidance will be considered when designing low permeability cover for consolidated material onsite.

Table 6.3-1: Comparative Analysis Summary

	Protection of Human Health and Environment	ARARs	Long Term Effectiveness	Reduction of TMV	Short Term Effectiveness	Implementability	Cost
RA-S1	○	○	○	○	○	●	●
RA-S2	○	○	○	○	○	●	●
RA-S3	●	●	●	◉	◉	◉	◉
RA-S4	●	●	●	◉	●	●	◉
RA-S5	●	●	●	◉	○	●	○
RA-G1	○	○	○	○	○	●	●
RA-G2	●	●	●	◉	●	●	●

Legend:
● Best meets this Criterion
◉ Partially meets this Criterion
○ Does not meet this Criterion

Figures



BASE MAP IS A PORTION OF THE FOLLOWING 7.5' x 15' USGS TOPOGRAPHIC QUADRANGLE: BROCKTON, MA. 1987

0 1000 2000

Scale in Feet

FIGURE 1.2-1
SITE LOCATION MAP

HATHEWAY AND PATTERSON SITE
15 COUNTY STREET
MANSFIELD, MASSACHUSETTS

M&E Metcalf & Eddy

TRC

Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

QUADRANGLE LOCATION

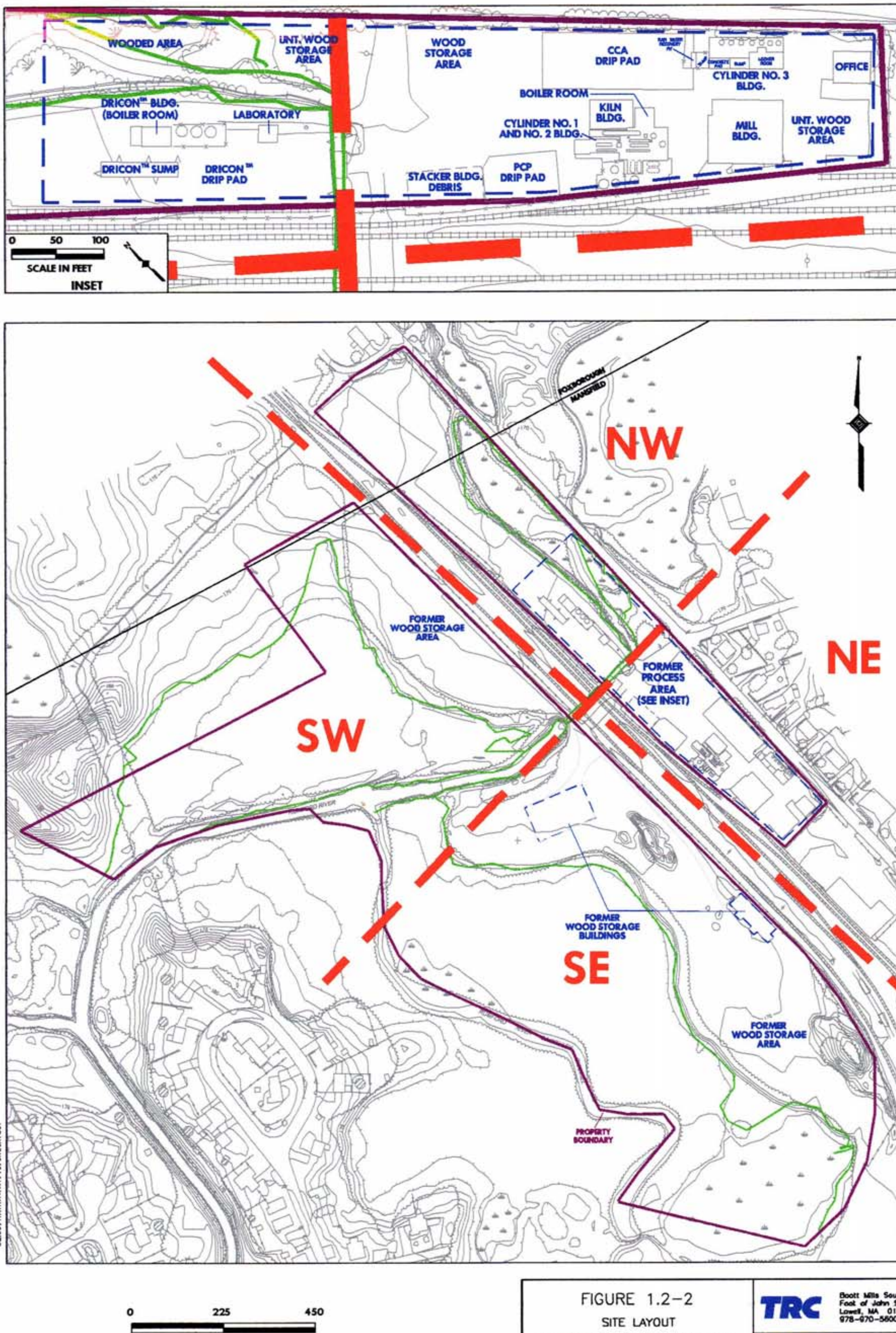
MASS

TRC PROJ. NO.: 02136-0490-01X39

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACT NO.: 107061

02136/HATHAWAY/FS/TOPO



0 225 450

SCALE IN FEET

FIGURE 1.2–2

SITE LAYOUT

HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

M&E Metcalf & Eddy

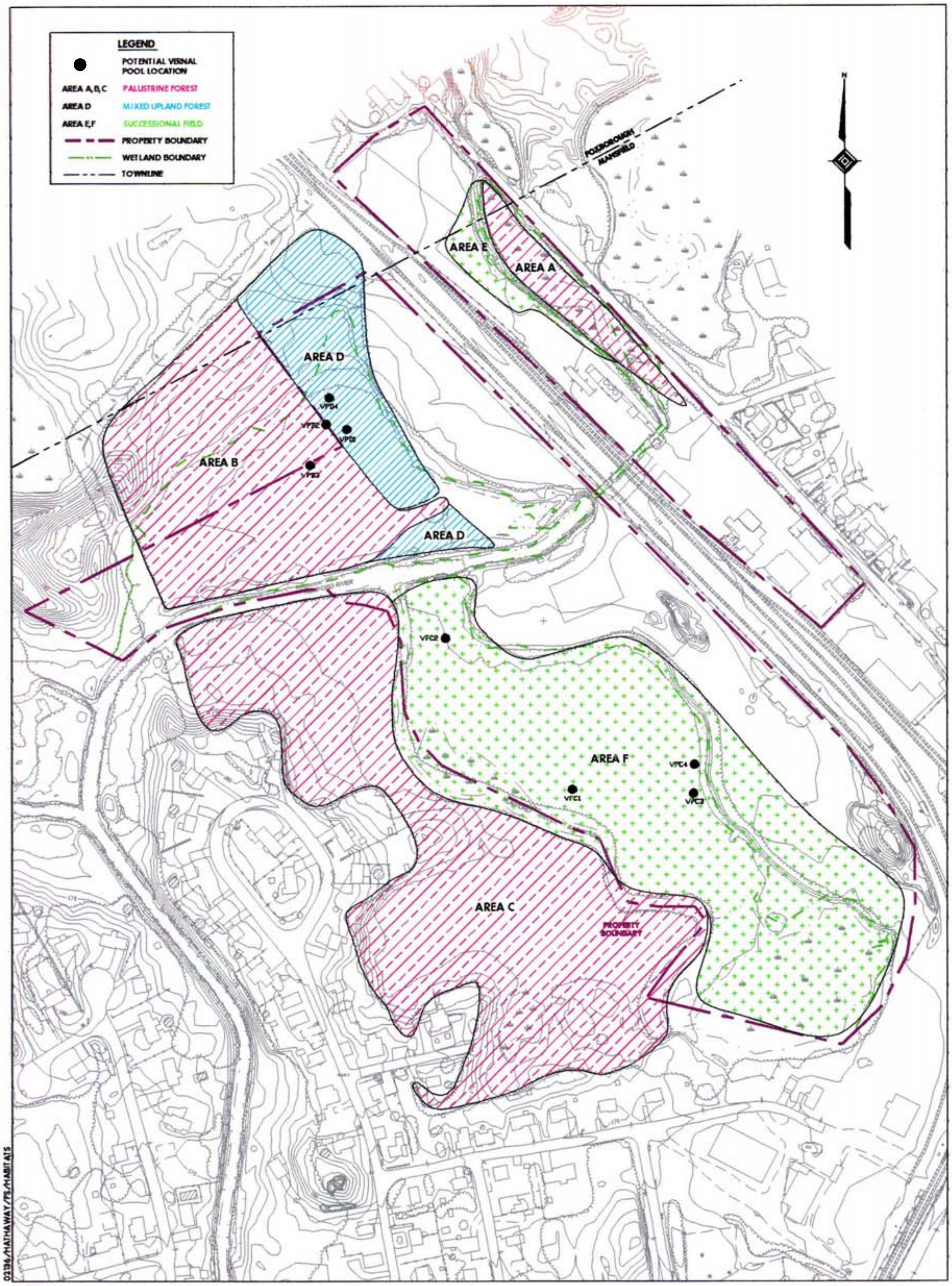
TRC

Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0490-01X39

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACTOR: 107061



02136/HATHAWAY/FS/HABITATS

SOURCE:
DELINEATED HABITAT AREAS WHERE INTERPRETED FROM A MAP (NOT TO SCALE) PREPARED BY METCALF & EDDY, FINAL HABITAT EVALUATION SURVEY TECHNICAL MEMORANDUM, FIGURE 2, HATHAWAY & PATTERSON SUPERFUND SITE, MANSFIELD, MASSACHUSETTS, JANUARY 2002.

0 225 450

SCALE IN FEET

FIGURE 1.3-1 ECOLOGICAL HABITATS	TRC Boott Mills South Foot of John Street Lowell, MA 01852 978-970-5600
HATHEWAY AND PATTERSON SITE 15 COUNTY ROAD MANSFIELD, MASSACHUSETTS	TRC PROJ. NO.: 02136-0490-01X3B EPA CONTRACT NO.: 68-W6-0042
M&E Metcalf & Eddy	RAC SUBCONTRACT NO.: 107061

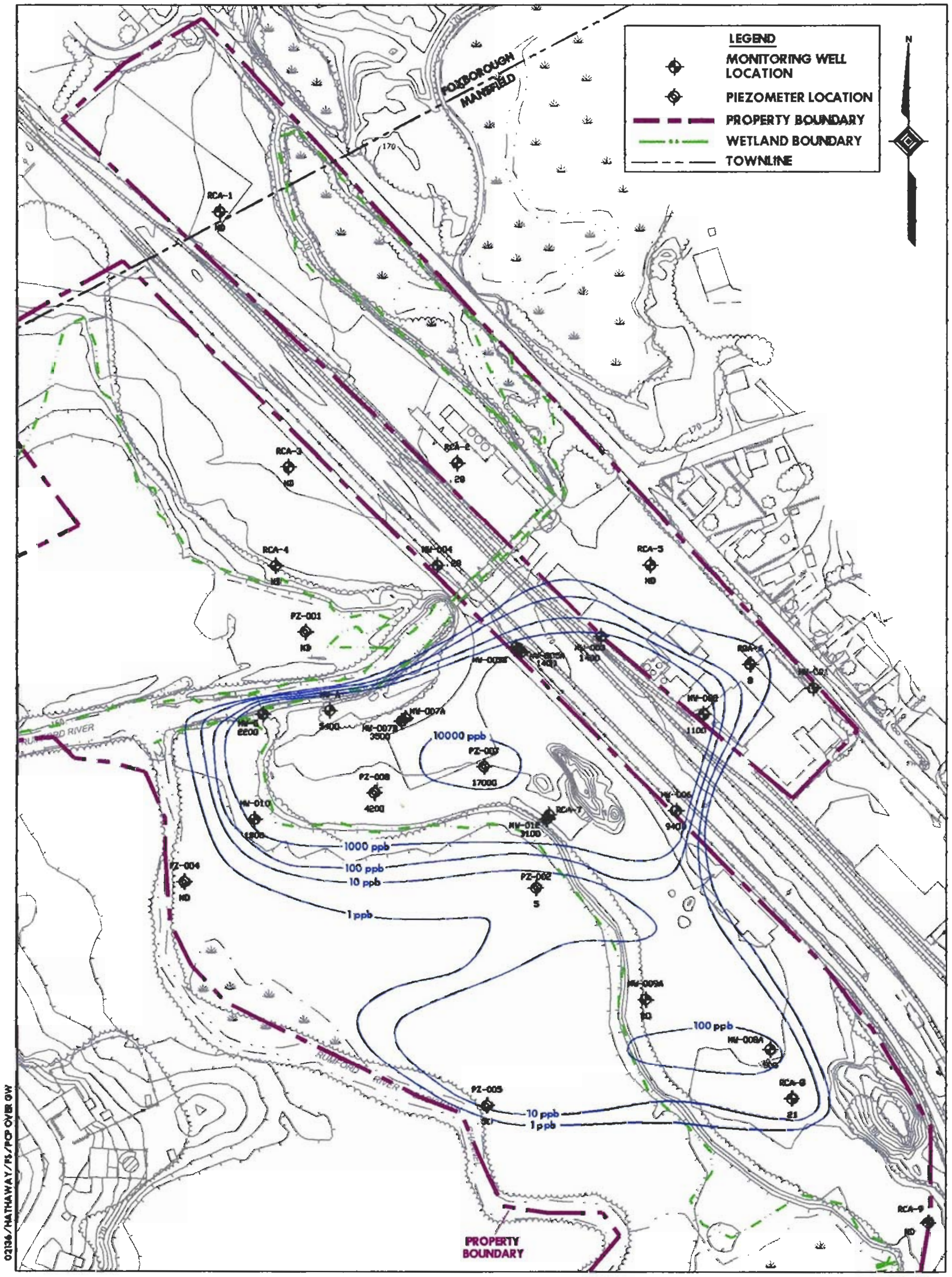


FIGURE 1.4-1

PCP CONCENTRATIONS IN OVERBURDEN GROUND WATER (MAXIMUM CONCENTRATION)

HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

M&E Metcalf & Eddy

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0490-01X38
EPA CONTRACT NO.: 68-W6-0042
RAC SUBCONTRACT NO.: 107051

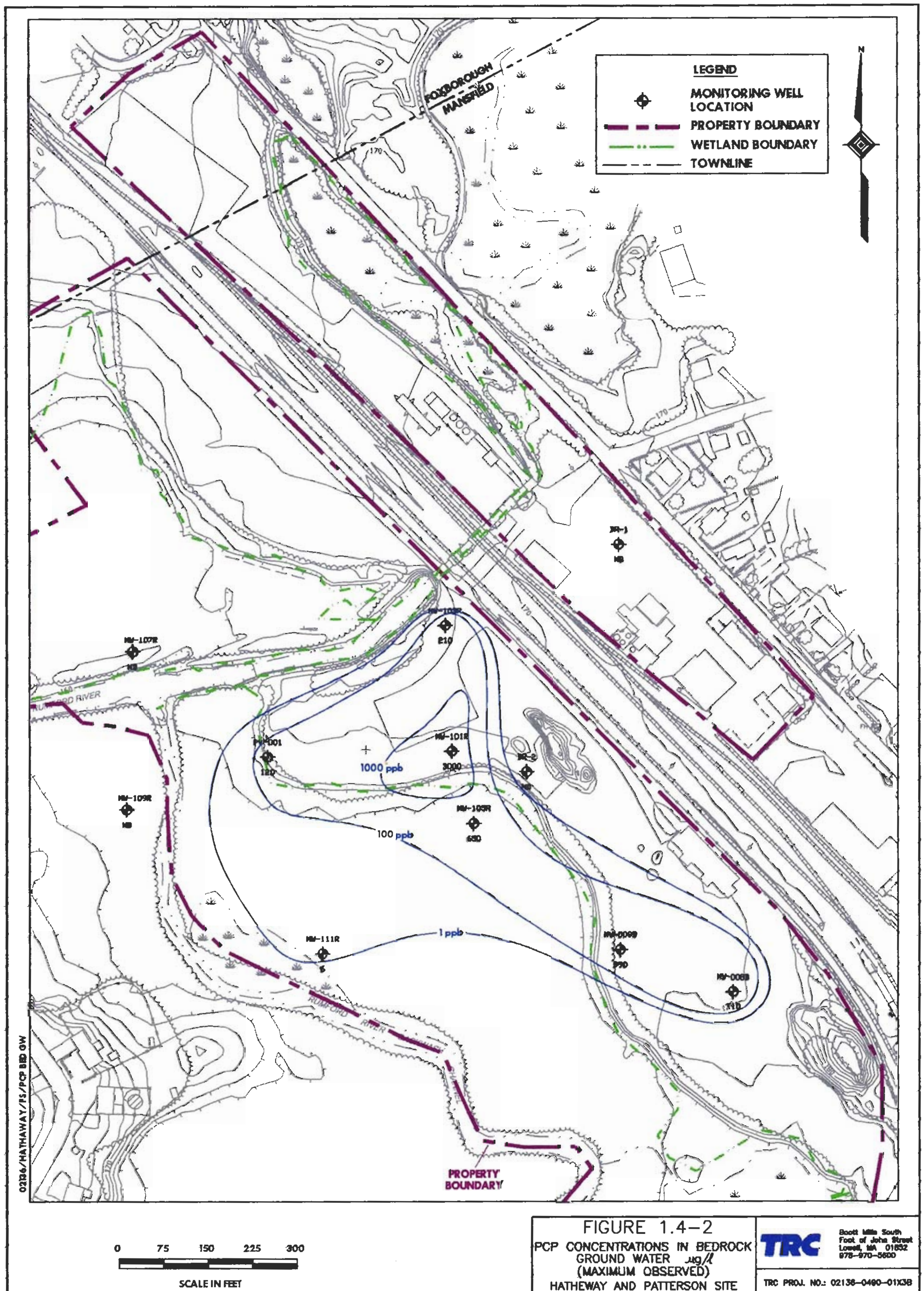


FIGURE 1.4–2
PCP CONCENTRATIONS IN BEDROCK GROUND WATER µg/l
(MAXIMUM OBSERVED)
HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

M&E Metcalf & Eddy

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0490-01X38

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACT NO.: 107061

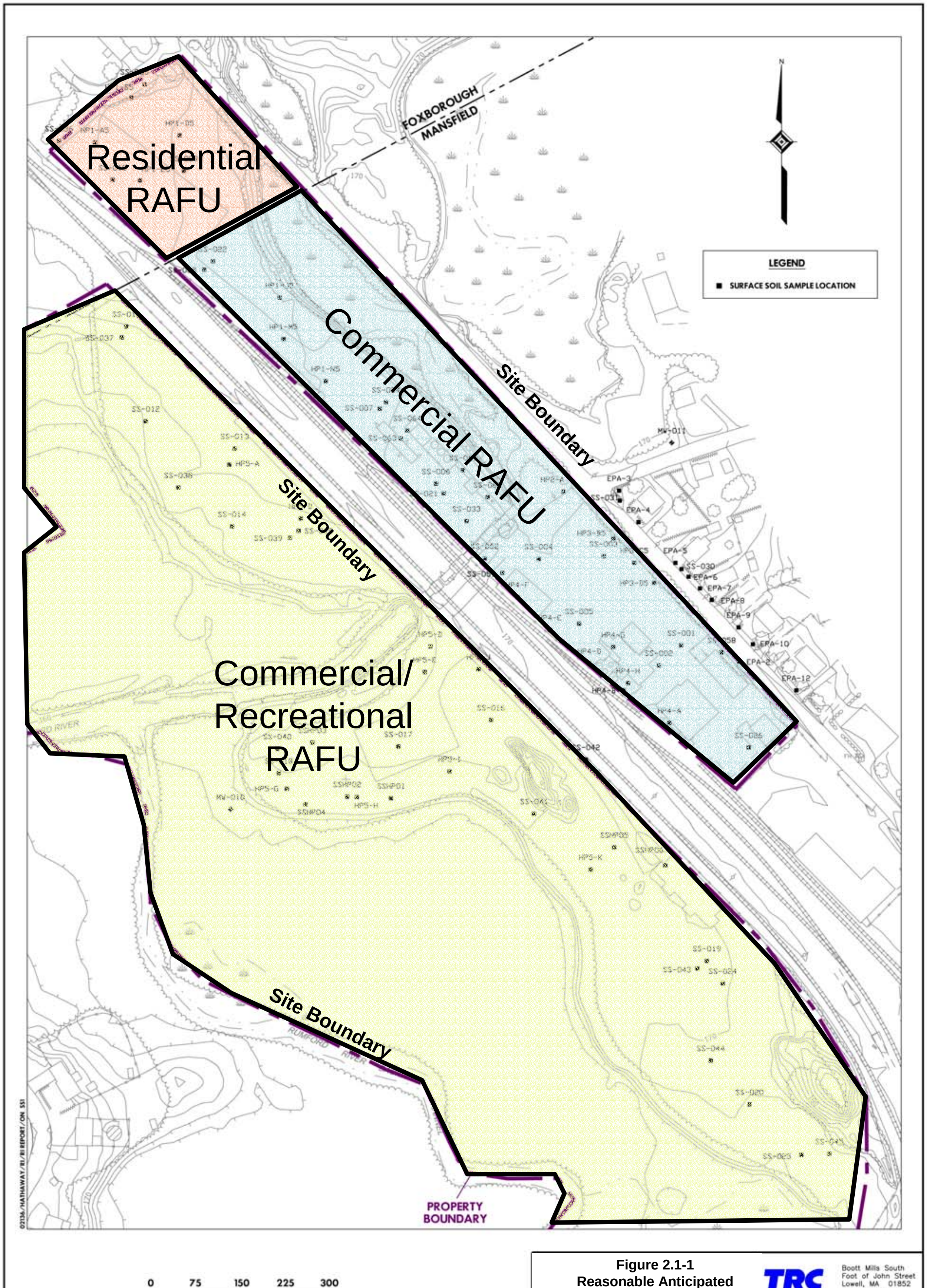


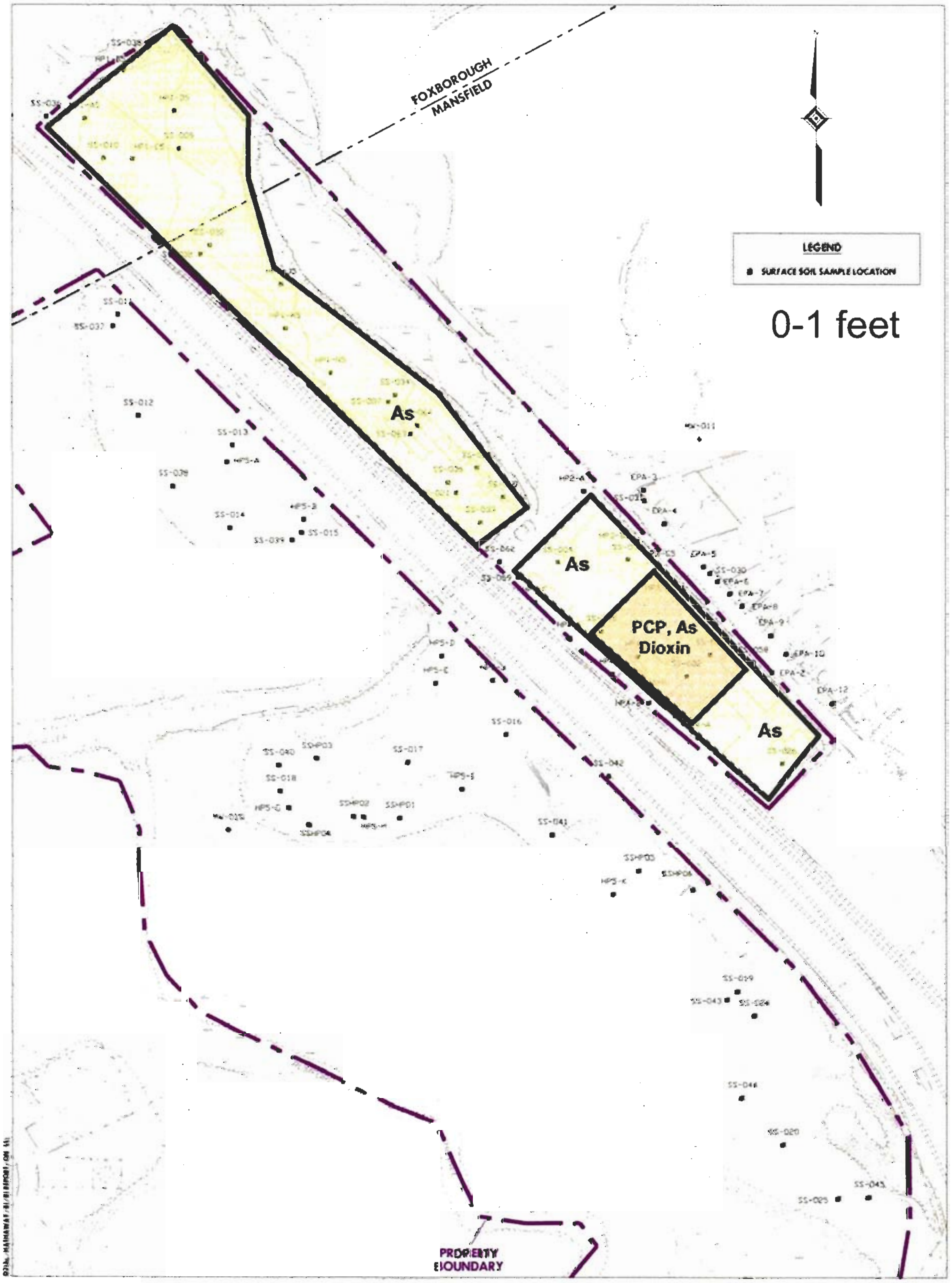
Figure 2.1-1
Reasonable Anticipated Future Use (RAFU)

HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0490-01X39
EPA CONTRACT NO.: 68-W6-0042
RAC SUBCONTRACT NO.: 107061

M&E Metcalf & Eddy



0 75 150 225 300

SCALE IN FEET

Figure 2.3-1: Soil Exceeding PRGs. 0-1 foot

HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

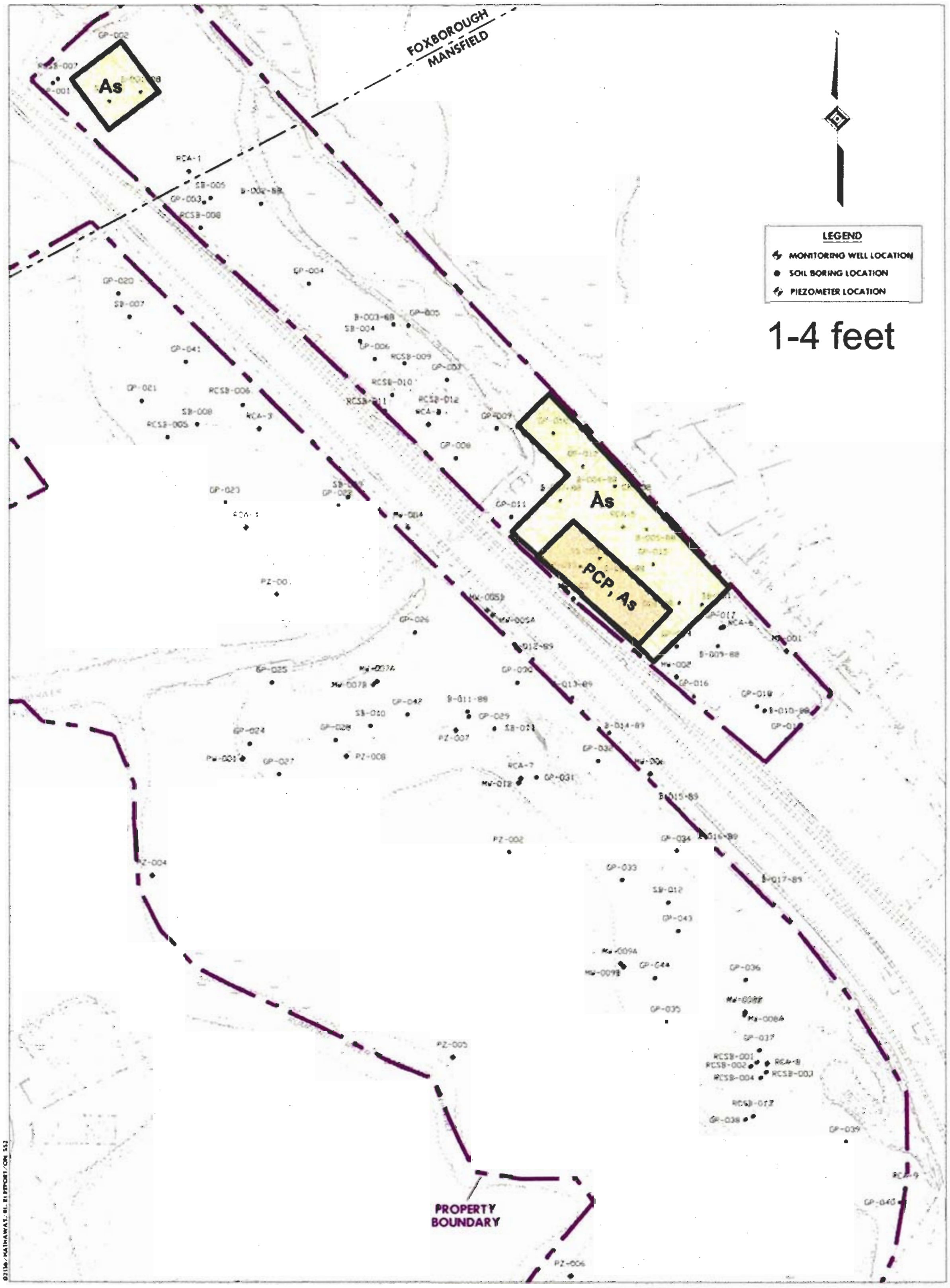
Metcalf & Eddy

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02156-0490-01K39

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACT NO.: 107081



0 75 150 225 300

SCALE IN FEET

Figure 2.3-2: Soil Exceeding PRGs. 1-4 feet

HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

M&E Metcalf & Eddy

TRC
Boott Mill South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO. 02136-0490-01X39

EPA CONTRACT NO. 68-W6-0042

RAC SUBCONTRACT NO. 107067

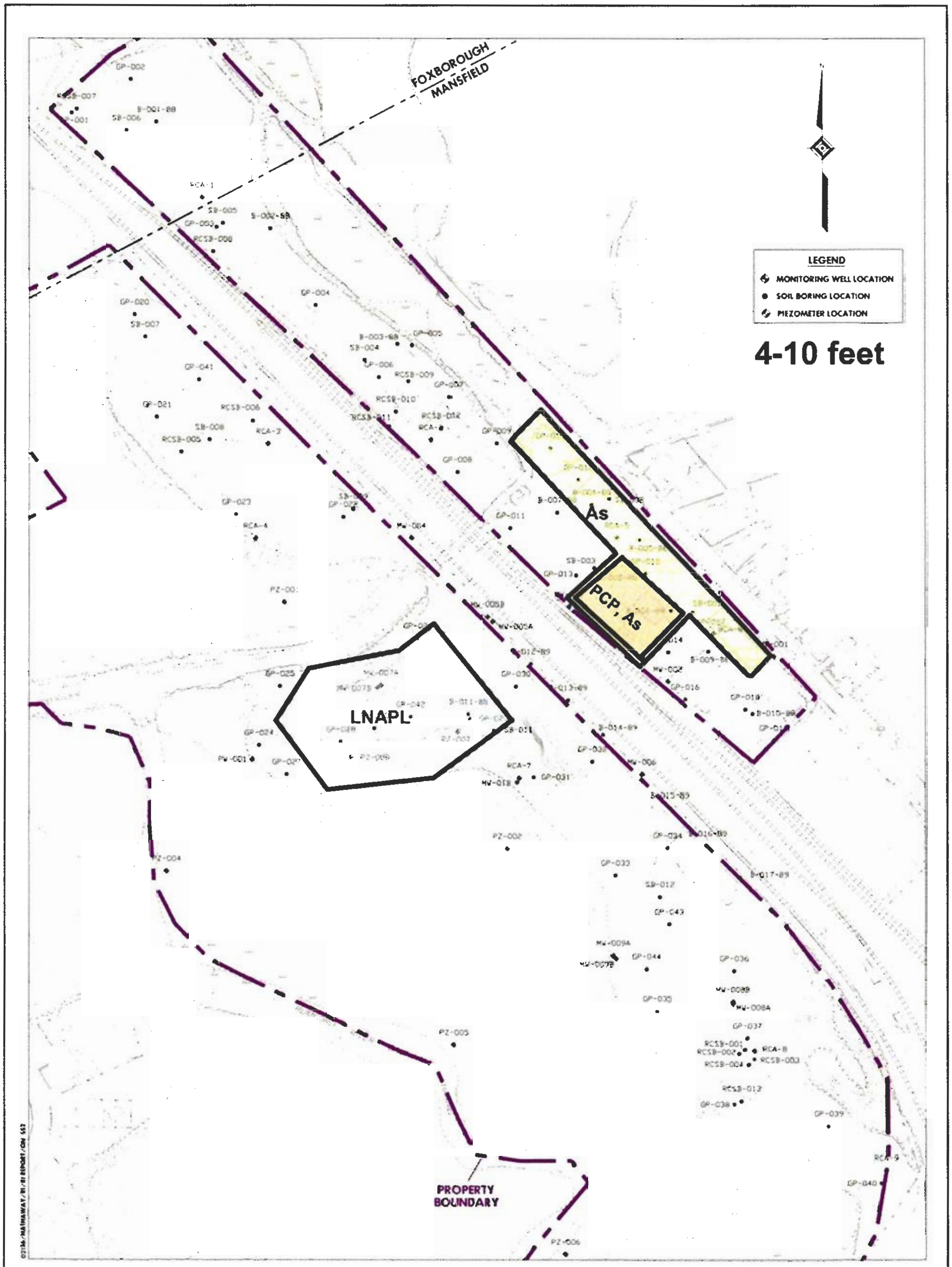


Figure 2.3-3: Soil Exceeding PRGs. 4-10 feet

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

TRC PROJ. NO. 02136-0490-01X39
EPA CONTRACT NO. 68-W6-0042
RAC SUBCONTRACT NO. 107061

M&E Metcalf & Eddy

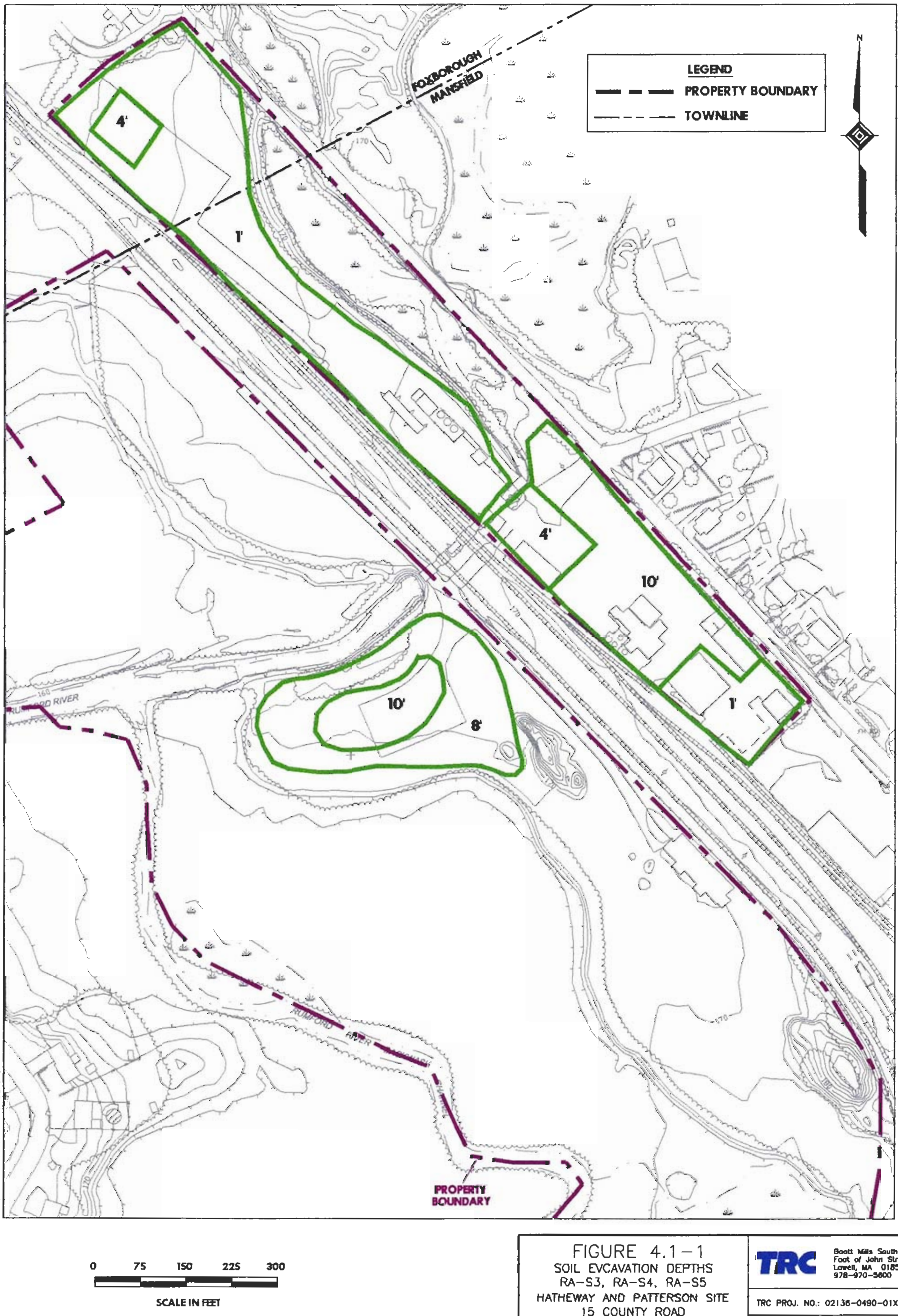


FIGURE 4.1-1
SOIL EVCAVATION DEPTHS
RA-S3, RA-S4, RA-S5
HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

M&E Metcalf & Eddy

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0490-01X38

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACT NO.: 107061

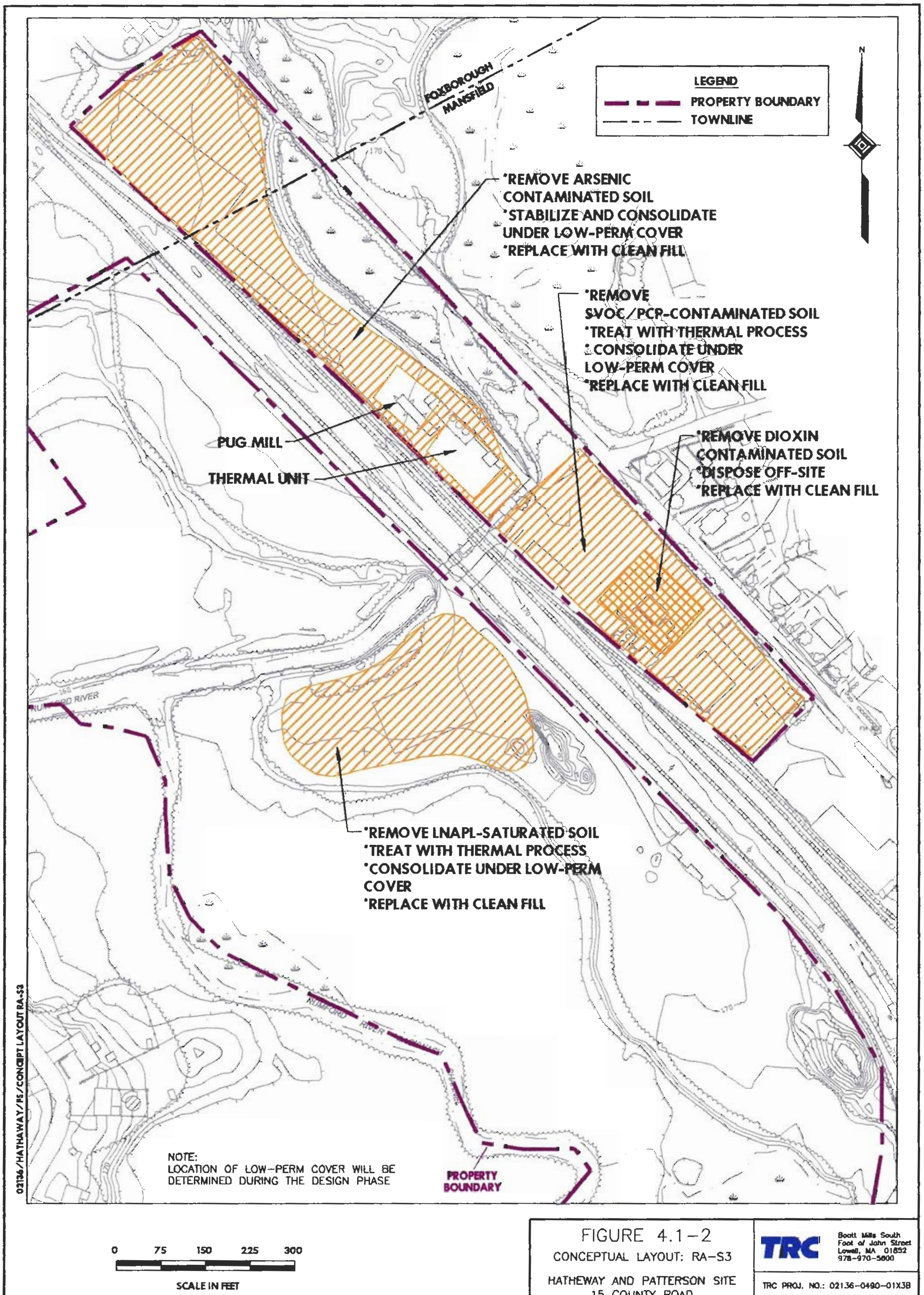


FIGURE 4.1-2

CONCEPTUAL LAYOUT: RA-S3

HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

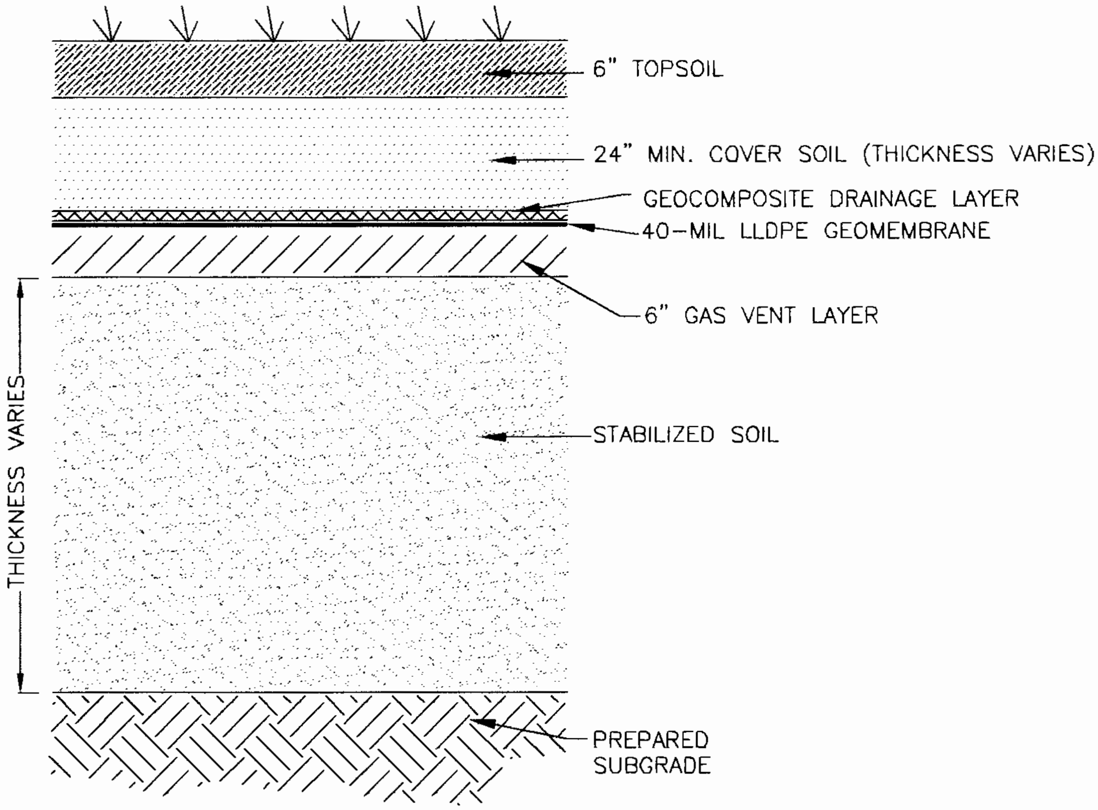
M&E Metcalf & Eddy

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0490-01X3B

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACT NO.: 107061



02136/HATHAWAY/FS/LOW_PERMI

FIGURE 4.1-3
LOW PERMEABILITY
COVER CROSS SECTION
HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

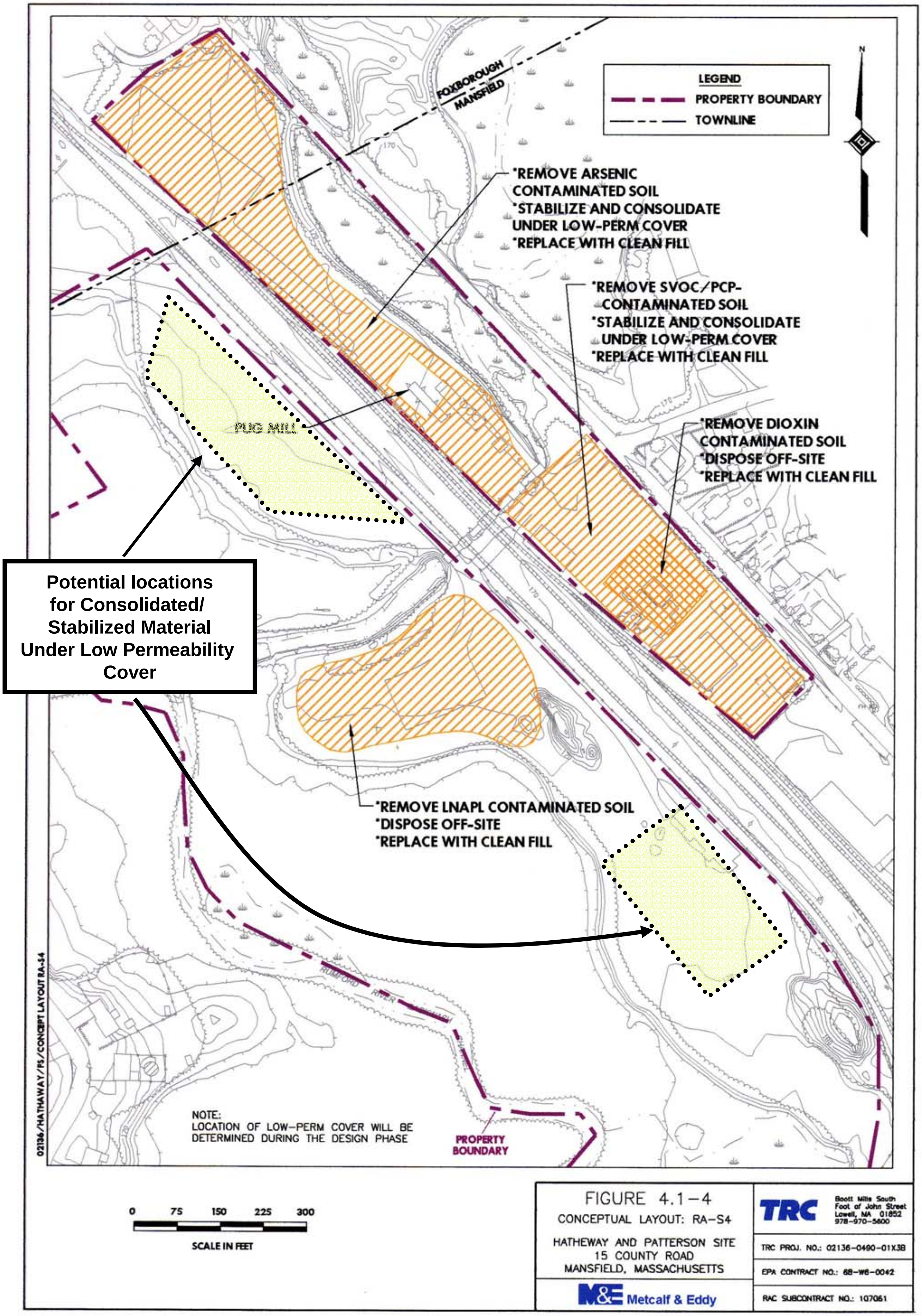
M&E Metcalf & Eddy

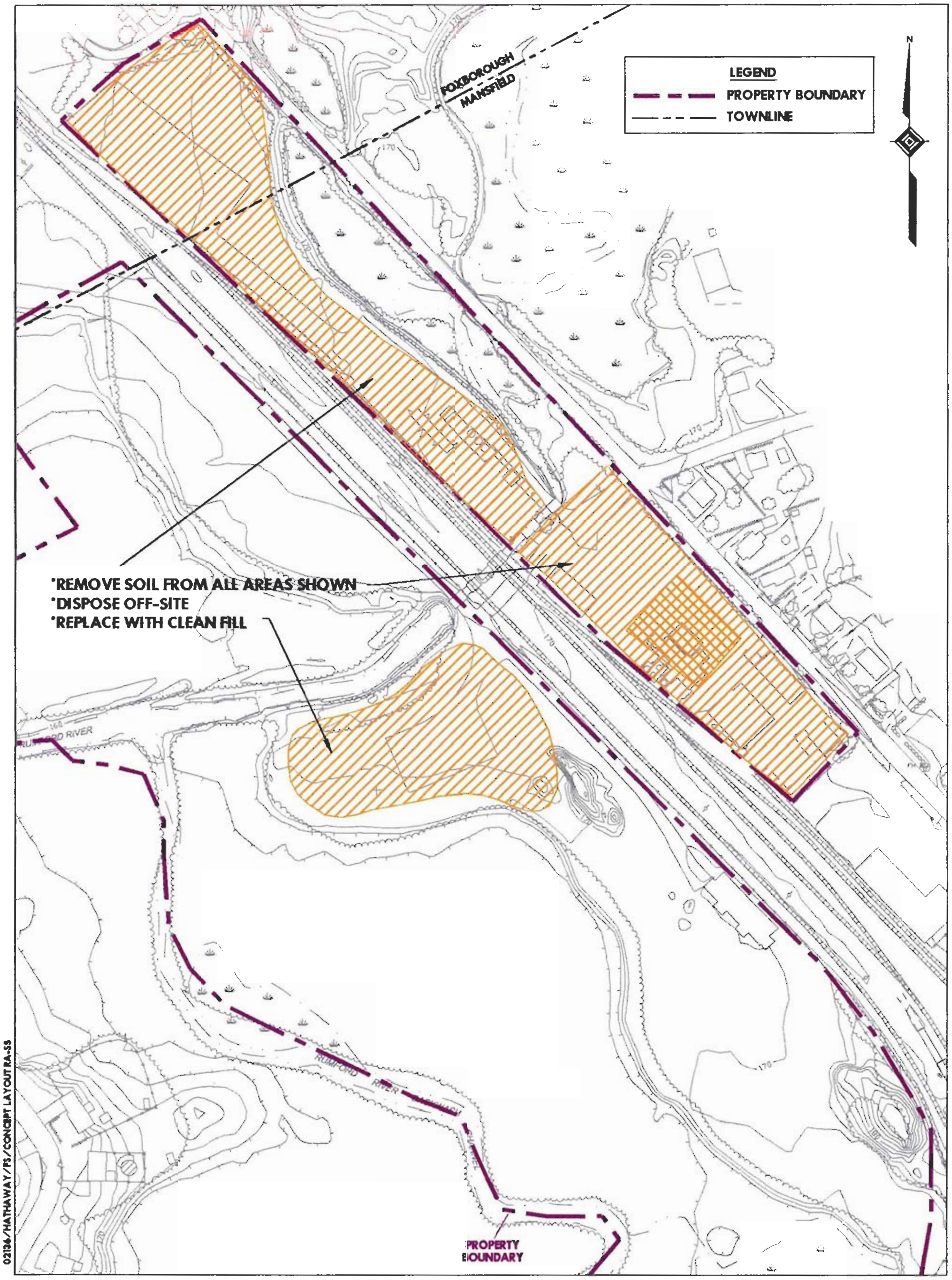
TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0490-01X38

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACT NO.: 107081


LEGEND
PROPERTY BOUNDARY
TOWNLINE
N
FOXBOROUGH
MANSFIELD
*REMOVE ARSENIC CONTAMINATED SOIL
*STABILIZE AND CONSOLIDATE UNDER LOW-PERM COVER
*REPLACE WITH CLEAN FILL
*REMOVE SVOC/PCP-CONTAMINATED SOIL
*STABILIZE AND CONSOLIDATE UNDER LOW-PERM COVER
*REPLACE WITH CLEAN FILL
*REMOVE DIOXIN CONTAMINATED SOIL
*DISPOSE OFF-SITE
*REPLACE WITH CLEAN FILL
PUG MILL
Potential locations for Consolidated/ Stabilized Material Under Low Permeability Cover
*REMOVE LNAPL CONTAMINATED SOIL
*DISPOSE OFF-SITE
*REPLACE WITH CLEAN FILL
RUMFORD RIVER
NOTE: LOCATION OF LOW-PERM COVER WILL BE DETERMINED DURING THE DESIGN PHASE
PROPERTY BOUNDARY
02136/HATHAWAY/FS/CONCEPT LAYOUT RA-S4
0 75 150 225 300
SCALE IN FEET
FIGURE 4.1-4
CONCEPTUAL LAYOUT: RA-S4
HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS
M&E Metcalf & Eddy
TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600
TRC PROJ. NO.: 02136-0490-01X38
EPA CONTRACT NO.: 68-W6-0042
RAC SUBCONTRACT NO.: 107061



0 75 150 225 300

SCALE IN FEET

FIGURE 4.1-5
CONCEPTUAL LAYOUT: RA-S5

HATHEWAY AND PATTERSON SITE
15 COUNTY ROAD
MANSFIELD, MASSACHUSETTS

M&E Metcalf & Eddy

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0490-01X38

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACT NO.: 107061

Appendix A
Town of Mansfield Reuse Letter dated 4/7/05

TOWN OF MANSFIELD, MASSACHUSETTS

Six Park Row, Mansfield, MA 02048

BOARD OF SELECTMEN

Steven W. MacCaffrie, Chairman
Roger S. Achille, Vice Chairman
Bernard J. Dolan, Clerk
Louis P. Amoruso
Michael W. McCue

Telephone: 508-261-7372
Fax: 508-261-7498

March 31, 2005

David Lederer
United States Environmental Protection Agency
Region One
One Congress Street, Suite 1100
Boston, MA 02114-2023

Dear Mr. Lederer:

Pursuant to an EPA reuse planning grant which was awarded to the Town of Mansfield to study the reuse options associated with the Hatheway and Patterson Site located on County Street, please be advised that on Tuesday, March 29th, Ken Buckland of the Cecil Group discussed various options regarding the reuse of the property. According to the interested parties present at that meeting, it was determined that the reasonably anticipated future use of the site will be commercial use to the front parcel located on County Street and on the back parcel either Open Space or Commercial, whichever is considered by EPA to be the higher standard for clean-up. Furthermore, the Town of Mansfield understands that necessary and appropriate deed restrictions will be place on the property in accordance with the RAFU, which establishes the basis of the allowable uses given the standard of clean up for the site.

The Town of Mansfield is anxious to move forward on clean-up initiatives based on the town's desired reuse option for the site as outlined in the preceding paragraph. We are also discussing various development options for Transit Oriented Development initiatives, which will link the Train Station to this parcel and abutting parcels (located to the south of the Hatheway and Patterson site). We will begin the planning phase within the next few weeks and will conclude that phase in early October of 2005.

If you have any questions or desire additional information, please fee free to contact John D'Agostino, Town Manager at 508-261-7370.

Sincerely yours,

Steven W. MacCaffrie
Chairman, Board of Selectmen

Cc: Planning Board
Zoning Board
Conservation Commission

Appendix B
MA DEP Use and Value Determination

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
SOUTHEAST REGIONAL OFFICE
20 RIVERSIDE DRIVE, LAKEVILLE, MA 02347 508-946-2700

MITT ROMNEY
Governor

KERRY HEALEY
Lieutenant Governor

ELLEN ROY HERZFELDER
Secretary

ROBERT W. GOLLEDGE, Jr.
Commissioner

January 21, 2005

Mr. Robert Cianciarulo, Chief
Massachusetts Superfund Section
Office of Site Remediation and Restoration
U.S. EPA Region I
1 Congress Street
Suite 1100 (HBO)
Boston, MA 02114

RE: Groundwater Use and Value Determination
Hatheway and Patterson Superfund Site

Dear Mr. Cianciarulo:

Enclosed please find the Groundwater Use and Value Determination prepared by the Department (DEP) for the Hatheway and Patterson Superfund Site. This Use and Value Determination was conducted by the DEP, pursuant to the finalized Guidance developed by the EPA.

In determining the use and value of the groundwater in the vicinity of the Hatheway and Patterson Site, we referred to the aquifer classification contained in the Massachusetts Contingency Plan (MCP). The classification in the MCP gives consideration to all of the factors in the Use and Value Guidance. Enclosed with the Use and Value Determination are copies of the GIS maps (1 mile and 4 mile radii) used to determine the aquifer classification. These maps provides a variety of information, including the USGS yield classification, the presence of public water supplies and zones of protection, surface water bodies, wetlands, protected open space areas, and drainage basin boundaries.

If you have any questions regarding this letter, please contact me at 292-5697.

Very truly yours,

Jay Naparstek

Jay Naparstek,
Deputy Division Director

GROUNDWATER USE AND VALUE DETERMINATION

Hatheway and Patterson Superfund Site
Mansfield, Massachusetts

January 2005

Consistent with the Environmental Protection Agency's (EPA) 1996 Final Ground Water Use and Value Determination Guidance, the Department has developed a "Use and Value Determination" of the groundwater at and in the vicinity of the Hatheway and Patterson Site (the "Site"). The purpose of the Use and Value Determination is to identify whether the aquifer at the site should be considered of "High, Medium," or "Low" use and value. In the development of its Determination, the Department has applied the criteria for groundwater classification as promulgated in the Massachusetts Contingency Plan (MCP). The classification contained in the MCP considers criteria similar to those recommended in the Use and Value Guidance. The Department's recommendation supports a *low use and value* for the groundwater. Outlined below is an explanation for the determination.

The Hatheway and Patterson Superfund Site covers approximately 38 acres of land in Mansfield, Massachusetts. Groundwater at the site flows in a southwesterly direction and discharges to the Rumford River, which flows from north to south. The Rumford River appears to capture most or all of the flow from the site. Contamination at the Site includes soils containing semi-volatile organics, pentachlorophenol, arsenic, chromium, lead, dioxins, and petroleum hydrocarbons; and groundwater containing semi-volatile organics, metals, dioxins, and petroleum hydrocarbons.

The groundwater beneath and in the vicinity of the Site is not classified as a current or potential drinking water supply. The closest municipal water supply wells are located approximately one mile to the east. An approved Zone II extends to approximately one-quarter mile to the east of the site. There is an EPA designated Sole Source Aquifer also located approximately one-quarter mile to the east. Wetland areas are located to the east, northeast and southwest of the site. The aquifer underlying the Site is classified as low yield by the United States Geological Survey (USGS). The Site Area aquifer is classified as both GW-2 and GW-3 (see description below).

GW-2 This designation addresses areas where there is a potential for migration of vapors from groundwater to occupied structures. The classification applies to locations where groundwater has an average annual depth of 15 feet or less and where there is an occupied building or structure within a 30-foot surface radius of that groundwater.

GW-3 This designation considers the impacts and risks associated with the discharge of groundwater to surface water, and therefore applies to all groundwater.

Considering this determination and the site conditions, the groundwater risk evaluation and cleanup decisions should consider, but not be limited to the following:

Human Health: a) vapor seepage into buildings,
b) site excavation activities that may expose workers to contaminated groundwater and vapors,

c) discharge to surface water and potential exposure routes (e.g. wading, other recreational activities) potential for migration of contaminated groundwater to areas of higher groundwater use and value.

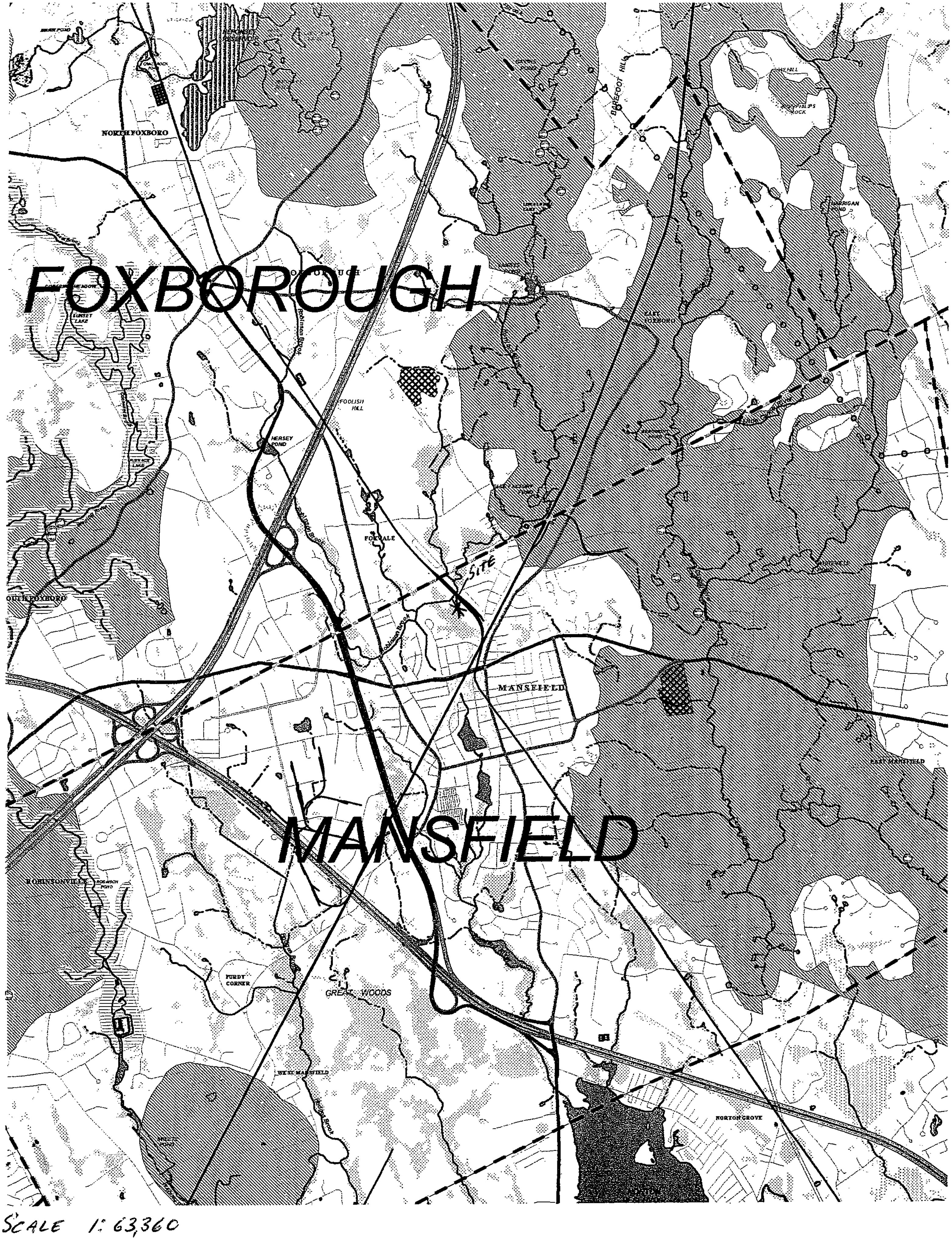
Ecological a) effects to wetlands and river biota.

In light of the use and value factors and similar criteria established in the MCP that were examined in this determination, the Department recommends a *low use and value* for the Site groundwater.

TABLE 1

HATHEWAY AND PATTERSON SITE GROUNDWATER USE AND VALUE DETERMINATION
January, 2005

USE AND VALUE FACTORS	RATING	HATHEWAY AND PATTERSON SITE (4-0571) SITE-SPECIFIC DETERMINATION
1. Quantity	Low	- Aquifer would be considered low to medium yield based on hydraulic conductivity values determined at the site.
2. Quality	High	- Water quality, other than that impacted by site contaminants, is believed to be good.
3. Current Public Water Supply Systems	Medium	- The nearest pubic water supplies are approximately one mile from the site. An approved Zone II area exists approximately ¼ mile east of the site.
4. Current Private Drinking Water Supply Wells	Low	-private drinking water supplies are located in the surrounding area, but they are cross gradient of the site and are outside of the extent of contamination.
5. Likelihood and Identification of Future Drinking Water Use	Low	-Site is zoned for industrial use, residential properties exist within one half mile of the Site -Not designated by the Town as an area for future drinking. -No current Activity and Use Limitations on the Study Area properties (it is expected that there will be groundwater use restrictions).
6. Other Current or Reasonable Expected Ground Water Use(s) in Review Area	Low	- On-site businesses use public water. Not expected to use site water for non-potable uses.
7. Ecological Value	Low	-Groundwater discharges to the Rumford River - No Ecological risk identified through RI Risk Assessment. - No Endangered species habitat exists on-site.
8. Public Opinion	Low	-Public appears to place minimal value for on-site groundwater.



SCALE 1:63,360
1 INCH = 1 MILE

Appendix C
US Fish and Wildlife Letter

16.1

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

RE: Job #101715.0057.0001
Mansfield and Foxborough, Massachusetts

September 28, 2001

Antony M. Rodolakis
Metcalf & Eddy
30 Harvard Mill Square
P.O. Box 4071
Wakefield, MA 01880-5371

Dear Mr. Rodolakis:

This responds to your August 20, 2001 letter requesting information on the presence of federally-listed and proposed, endangered or threatened species in relation to the proposed ecological risk assessment to be conducted at a site along the Rumford River in Mansfield and Foxborough, Massachusetts. Our comments are provided in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543).

Based on information currently available to us, no federally-listed or proposed, threatened or endangered species under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project areas, with the exception of occasional transient bald eagles (*Haliaeetus leucocephalus*). Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required. Should project plans change, or additional information on listed or proposed species becomes available, this determination may be reconsidered.

Thank you for your cooperation. Please contact me at 603-223-2541 if we can be of further assistance. **Please make note of our new address, as shown above.**

Sincerely yours,

Philip A. Morrison

for Michael Amaral
Endangered Species Specialist
New England Field Office

Appendix D
Commonwealth of Massachusetts
Division of Fisheries and Wildlife

16.1

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

Wayne F. MacCallum, *Director*

September 7, 2001

Hathaway + Patterson
16.1
225318

SDMS DocID 000225318

Antony M. Rodolakis
Metcalf & Eddy
30 Harvard Mill Square
P.O. Box 4071
Wakefield, MA 01880-5371

Re: Ecological Risk Assessment along the Rumford River
Mansfield, Foxborough, MA
NHESP File: 01-9345

Dear Mr. Rodolakis,

Thank you for contacting the Natural Heritage and Endangered Species Program for information regarding state-protected rare species in the vicinity of the above referenced site. I have reviewed the site and would like to offer the following comments.

Our database indicates that the site is near Priority/Estimated Habitat PH 1216/WH 6067, which has been delineated for the Blue-spotted Salamander (*Ambystoma laterale*), a species of special concern in Massachusetts, and the Spotted Turtle (*Clemmys guttata*), also a species of special concern. The site is also near Priority Habitat PH 1203, which has been delineated for the Southern Hairstreak (*Fixsenia favonius ontario*), a species of special concern. These species are protected under the Massachusetts Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00) as well as the state's Wetlands Protection Act (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for these species can be found on our website at www.state.ma.us/dfwele/dfw.

This evaluation is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. Should your site plans change, or new rare species information become available, this evaluation may be reconsidered.

Please do not hesitate to call me at (508)792-7270 x154 if you have any questions.

Sincerely,

Christine Vaccaro

Christine Vaccaro
Environmental Review Assistant

Appendix E
M&E Risk Assessment Memo for Recreational Use of SE/SW Quadrant

METCALF & EDDY | AECOM

Metcalf & Eddy
701 Edgewater Drive, Wakefield, Massachusetts 01880-5371
T 781.246.5200 F 781.245.6293 www.m-e.com

Memorandum

Date:	April 5, 2005
To:	Cinthia McLane
From:	Diane Silverman
Subject:	Hatheway & Patterson WA#142 - Risk Calculations for Recreational Use of SE/SW Quadrant

Distribution:

As requested by EPA, the following documents risk and hazard calculations performed for future recreational use at the SE/SW quadrant area of the Hatheway & Patterson Superfund Site. The future recreational receptor may also be exposed to sediment in the Rumford River adjacent to the site. The baseline human health risk assessment performed for the site (January 2005) estimated risks and hazards for the SE/SW quadrant assuming future commercial and future residential use of this area. Future recreational use was not included in the baseline evaluation. Because the reuse plan for the site is considering passive recreational use of this area, estimation of recreational risks and hazards have been performed to confirm that remedial decisions for the site, based on future commercial use, are also adequately protective of future recreational site use.

Recreational exposures were assumed for young children (1-6 years of age) and adults exposed to soil and sediment by the dermal contact and incidental ingestion exposure routes. Surface soil, subsurface soil, and sediment exposures were included in the evaluation. Age-specific exposure assumptions for surface area, ingestion rate, and exposure period were consistent with those used for the residential evaluation (January 2005). However, the residential exposure frequency was adjusted from 150 days per year and 104 days per year for soil and sediment, respectively, to 52 days per year (2 days per week for the warmest six months of the year) to be more applicable to a recreational rather than a residential scenario. Tables 1 through 3 document the recreational risk and hazard calculations for surface soil, subsurface soil, and sediment, respectively. It should be noted that the recreational scenario evaluated likely over-estimates anticipated recreational exposures due to the assumptions that recreational users will be exposed for a 30-year residential exposure duration and that children younger than two years of age will be on-site.

The following table summarizes the comparison of commercial and recreational risks and hazards:

Receptor	Media	ILCR	HI
Commercial Worker	Surface Soil	7×10^{-5}	0.5
	Subsurface Soil	1×10^{-4}	0.2
	Sediment	NE	NE
Recreational User	Surface Soil	4×10^{-5}	0.9
	Subsurface Soil	8×10^{-5}	0.3
	Sediment	8×10^{-5}	0.4

ILCR = Incremental Lifetime Cancer Risk HI = Noncancer Hazard Index NE = Not Evaluated

The results indicate that, for soil exposure, the commercial scenario is more conservative than the recreational scenario when considering carcinogenic risk. The recreational scenario is slightly more conservative for the estimation of noncarcinogenic hazard. However, the estimated hazard index for both scenarios in less than the EPA target hazard index (HI) of 1. Therefore, remedial decisions for soil based on the commercial scenario for the SE/SW quadrant are also protective of future recreational site use.

No comparison is provided for sediment because the future commercial worker at the SE/SW quadrant was not assumed to be exposed to sediment in the Rumford River in the baseline risk assessment. However, the evaluation indicates that the risk and hazard associated with recreational sediment exposure is within the EPA target cancer risk range of 10^{-6} to 10^{-4} and less than the target HI of 1.

TABLE 1
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
HATHEWAY & PATTERSON SUPERFUND SITE

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	SE/SW Quadrants											
			Acetophenone	N/A	- -	N/A	- -	N/A	General Toxicity	2E-06	- -	N/A	2E-06
			Benzo(a)anthracene	2E-07	- -	7E-08	- -	2E-07	N/A	N/A	- -	N/A	N/A
			Benzo(a)pyrene	1E-06	- -	4E-07	- -	2E-06	N/A	N/A	- -	N/A	N/A
			Benzo(b)fluoranthene	1E-07	- -	5E-08	- -	2E-07	N/A	N/A	- -	N/A	N/A
			Dibenz(a,h)anthracene	3E-07	- -	1E-07	- -	4E-07	N/A	N/A	- -	N/A	N/A
			Dioxin TEQ	7E-06	- -	7E-07	- -	8E-06	N/A	N/A	- -	N/A	N/A
			Antimony	N/A	- -	N/A	- -	N/A	General Toxicity	1E-02	- -	N/A	1E-02
			Arsenic	3E-05	- -	3E-06	- -	3E-05	Skin	5E-01	- -	4E-02	6E-01
			Chromium	N/A	- -	N/A	- -	N/A	GI System	2E-01	- -	N/A	2E-01
			Lead										
			Manganese	N/A	- -	N/A	- -	N/A	CNS	8E-03	- -	N/A	8E-03
			Thallium	N/A	- -	N/A	- -	N/A	Blood	2E-02	- -	N/A	2E-02
			Vanadium	N/A	- -	N/A	- -	N/A	Kidney	3E-02	- -	N/A	3E-02
			Chemical Total	4E-05	- -	4E-06	- -	4E-05		8E-01	- -	4E-02	9E-01
			Radionuclide Total										
		Exposure Point Total						4E-05					9E-01
	Exposure Medium Total							4E-05					9E-01
Medium Total								4E-05					9E-01

TABLE 2

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

HATHEWAY & PATTERSON SUPERFUND SITE

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Subsurface Soil	SE/SW Quadrants											
			2,4-Dinitrophenol	N/A	- -	N/A	- -	N/A	Eye	4E-02	- -	N/A	4E-02
			Pentachlorophenol	8E-06	- -	7E-06	- -	2E-05	Liver/Kidney	2E-02	- -	1E-02	3E-02
			Dioxin TEQ	5E-05	- -	4E-06	- -	5E-05	N/A	N/A	- -	N/A	N/A
			Arsenic	9E-06	- -	8E-07	- -	1E-05	Skin	2E-01	- -	1E-02	2E-01
			Chromium	N/A	- -	N/A	- -	N/A	GI System	2E-02	- -	N/A	2E-02
			Lead										
			Manganese	N/A	- -	N/A	- -	N/A	CNS	8E-03	- -	N/A	8E-03
			Vanadium	N/A	- -	N/A	- -	N/A	Kidney	5E-02	- -	N/A	5E-02
			Chemical Total	6E-05	- -	1E-05	- -	8E-05		3E-01	- -	3E-02	3E-01
			Radionuclide Total										
		Exposure Point Total						8E-05					3E-01
	Exposure Medium Total							8E-05					3E-01
Medium Total								8E-05					3E-01

TABLE 3

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

HATHEWAY & PATTERSON SUPERFUND SITE

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Rumford River Adjacent to Site	Acetophenone	N/A	- -	N/A	- -	N/A	General Toxicity	4E-05	- -	N/A	4E-05
			Benzo(a)anthracene	2E-07	- -	1E-07	- -	3E-07	N/A	N/A	- -	N/A	N/A
			Benzo(a)pyrene	2E-06	- -	9E-07	- -	3E-06	N/A	N/A	- -	N/A	N/A
			Benzo(b)fluoranthene	3E-07	- -	1E-07	- -	4E-07	N/A	N/A	- -	N/A	N/A
			Dibenz(a,h)anthracene	5E-07	- -	2E-07	- -	6E-07	N/A	N/A	- -	N/A	N/A
			Indeno(1,2,3-cd)pyrene	2E-07	- -	8E-08	- -	3E-07	N/A	N/A	- -	N/A	N/A
			Pentachlorophenol	2E-06	- -	2E-06	- -	4E-06	Liver/Kidney	5E-03	- -	4E-03	9E-03
			Dioxin TEQ	6E-05	- -	5E-06	- -	6E-05	N/A	N/A	- -	N/A	N/A
			Antimony	N/A	- -	N/A	- -	N/A	General Toxicity	2E-02	- -	N/A	2E-02
			Arsenic	6E-06	- -	6E-07	- -	7E-06	Skin	1E-01	- -	9E-03	1E-01
			Cadmium	N/A	- -	N/A	- -	N/A	Kidney	3E-03	- -	4E-04	4E-03
			Chromium	N/A	- -	N/A	- -	N/A	GI System	1E-01	- -	N/A	1E-01
			Lead										
			Manganese	N/A	- -	N/A	- -	N/A	CNS	1E-02	- -	N/A	1E-02
			Mercury	N/A	- -	N/A	- -	N/A	CNS	1E-02	- -	N/A	1E-02
			Thallium	N/A	- -	N/A	- -	N/A	Blood	3E-02	- -	N/A	3E-02
			Vanadium	N/A	- -	N/A	- -	N/A	Kidney	4E-02	- -	N/A	4E-02
			Chemical Total	7E-05	- -	9E-06	- -	8E-05		4E-01	- -	1E-02	4E-01
			Radionuclide Total										
		Exposure Point Total						8E-05					4E-01
	Exposure Medium Total							8E-05					4E-01
Medium Total								8E-05					4E-01

Appendix F
Ground Water PRG Calculations

Calculation of Ground Water PRGs based on AWQC

Plume Width	150	ft/d	Measured from RI info
Plume Thickness	15	ft/d	Measured from RI info
K (hydraukic conductivity)	14	ft/d	RI Avg of three tests
I (horiziontal hydraulic gradient	0.025	ft/ft	Measured from RI info
Qgw	787.5	cf/d	=(plume width)*(plume thickness)*i*K
7Q10 flow	1.08	cf/s	avg, from USGS Water Resources Investigations Report 99-4006, pp 95, 96
Qriv=7Q10 flow converted	93312	cf/d	

AWQC=

PCP	15	ppb
As	150	ppb
Cr	11	ppb
Cadmium	0.25	ppb
Copper	9	ppb
Lead	2.5	ppb
Nickel	52	ppb
Selenium	5	ppb
Zinc	120	ppb

GW PRG= =AWQC*(Qgw+Qriv)/Qgw

PCP	**1792**	**ppb**
As	**17924**	**ppb**
Cr	**1314**	**ppb**
Cadmium	**30**	**ppb**
Copper	**1075**	**ppb**
Lead	**299**	**ppb**
Nickel	**6214**	**ppb**
Selenium	**597**	**ppb**
Zinc	**14339**	**ppb**

Appendix G
EPA Articles on Stabilization/solidification of Wood Preservative Wastes

Published in " Environmental Progress", Vol.21,No.2, July 2002 , pp79-84

American Creosote Site Case Study: Solidification//Stabilization of Dioxins, PCP, and Creosote for $64 CY

Edward R. Bates
U.S. Environmental Protection Agency
Office of Research and Development
26 W. Martin Luther King Drive - MS 489
Cincinnati, Ohio 45268

Femi Akindele
U.S. Environmental Protection Agency
Region IV
61 Forsythe Street, S.W.
Atlanta, Georgia 30303-3104

Don Sprinkle
Tennessee Department of Environment and Conservation
362 Carriage House Drive
Jackson, Tennessee 38305-2222

ABSTRACT

Solidification/Stabilization (S/S) is a low cost remedial technology that has been extensively used for decades to treat soil contaminated with metals on Superfund sites. Increasingly it is being used with success to remediate sites that contain higher molecular weight organic compounds. This case study describes the development of S/S formations and their application to remediate the American Creosote Superfund Site in Jackson. Tennessee.

The US EPA National Risk Management Research Laboratory conducted successful treatability tests of innovative solidification/stabilization (S/S) formulations to treat soils contaminated with dioxins, pentachlorophenol (PCP), and creosote from four wood

preserving sites. Formulations developed during these studies were successful in reducing the mobility (leaching) of contaminants of concern by 95-99%. For one of these sites, the American Creosote Superfund site in Jackson, Tennessee, the US EPA in cooperation with the State of Tennessee conducted a successful remediation of 45,000 cubic yards during 1998 and 1999. The costs to excavate, treat, replace, and cap soil contaminated with dioxin, PCP, and creosote averaged $64 per cubic yard (about $40 ton). Formulations, design, operations, performance specifications, and costs are presented in this paper.

OVERVIEW

This article describes the remediation of the American Creosote Superfund Site, located at the edge of the city of Jackson, Tennessee, using S/S technology. Solidification is defined for this article as making a material into a free standing solid. Stabilization is defined as making the contaminants of concern less mobile as determined from a leaching test; S/S then combines both properties. The remediation and treatability studies described in this paper all used Portland cement as part of the reagent mix producing a solid monolithic, treated product. For a general description of S/S processes and applications, the reader may wish to refer to other publications[1-3]. For a general discussion of contaminants present at wood preserving sites and S/S treatability studies for other wood preserving sites, the reader may wish to refer to previous publications[4-12].

The American Creosote site in Jackson, Tennessee, (ACW site) encompasses 60 acres of marshy flood plain along the Forked Deer River just southwest of Jackson, Tennessee. The facility treated wood from the 1930's to 1981 using both creosote and PCP. Surface soils in an approximate eight acre main process and drip tracks area, consisting primarily of sands and silts, were contaminated by creosote, PCP, and dioxins. The main process area is underlain by a confining clay layer at a depth of approximately two to five feet limiting the depth to which soils were contaminated.

In 1996 the EPA completed a Focused Risk Assessment for the ACW site. Based on a future industrial use scenario and a defined risk of $1X10^{-4}$, soil action levels were defined for contaminants of concern. Later that same year the EPA, with concurrence from the State of Tennessee, signed a Record of Decision (ROD) which called for remediation by excavation, ex-situ treatment by S/S, and replacement of treated soil under a cap[13]. Following the ROD, a detail remedial design was developed by EPA in cooperation with the State of Tennessee. The State of Tennessee then bid the remediation under authority delegated by EPA through a Cooperative Agreement. The remediation was conducted during 1999 and early 2000, with construction oversight provided by the Tennessee Department of Environment and Conservation in Jackson, Tennessee. EPA Region IV provided administrative oversight and EPA's Office of Research and Development provided technical oversight during the construction. A summary of the overall site history is on Table 1.

SUBSTANTIAL COST SAVINGS

As noted in Table 2, site discovery occurred in 1981, leading to an emergency response action in 1983, to remove treatment chemicals and tanks, and listing of the site on the National Priority List (Superfund) in 1984. In 1988 a site wide Remedial Investigation/Feasibility Study (RI/FS) was completed. Remedial action alternatives identified and evaluated in the 1988 RI/FS are shown in Table 2. Costs of the alternatives ranged from a low of 25 million dollars, cap and monitor, to a high of $3,700 million dollars for excavating all contaminated soils to a depth of 120 feet. Note that the S/S alternative was estimated to cost 34 million dollars.

Following the completion of the FS in 1988, EPA Region IV conducted two very significant studies that had the effect of reducing the amount of soil requiring treatment from 194,000 cubic yards (cy) to 45,000 cy. The first, a Focused Remedial Investigation, was completed in 1993, and more precisely defined the location, depth, and volumes of contaminated soils. The second, a Focused Risk Assessment, was completed in 1996, and determined that dioxins were the major contaminant determining site risk. Based on these two studies, and the location of the site (edge of the city in an industrial area), EPA issued a ROD with concurrence from the State of Tennessee, in 1996[13]. The ROD defined an estimated 45,000 cubic yards of contaminated soil in the main processing area as the principal threat and set soil action level goals based on future industrial use for the site. The combination of more precisely defining the extent of the soils of concern and changing the basis of clean-up from "Residential" (with 1x10-6 risk) to "Industrial" (With 1x10-4 risk) reduced the volume of the soils requiring clean-up from 104,000 cy to 45,000 cy. Table 3 provides the soil action levels, while Table 4 compares the 1988 RI/FS soil cleanup requirements to those in the 1996 ROD, as implemented in 1999. As shown, estimated remediation costs were reduced approximately 90%, from 34.4 million dollars to 4.5 million dollars, while still reducing risk from site contaminants to an acceptable level.

TREATABILITY STUDIES

During 1996 and 1997, at the request of US EPA's Region IV, EPA's National Risk Management Research Laboratory conducted treatability tests on soils from the ACW site to establish that S/S treatment could be effective for the contaminants of concern, to evaluate various S/S formulations, and to develop approximate costs for S/S treatment[9]. Three rounds of bench scale tests were conducted. Site soils were excavated from five of the more highly contaminated areas, homogenized and screened to 0.5 inch minus in the field and shipped to laboratory for bench scale tests. Three rounds of treatability tests were conducted and many formulations evaluated. The most successful formulations are shown in Table 5.

The primary objective for all the S/S studies was to develop formulations that could treat all contaminants of concern, which included dioxins, PCP, and creosote PAHs, to meet treatment criteria. The treatment criteria (targets) were established in advance and are shown in Table 6, which also depicts the treatment results for the two most successful formulations. The primary leaching test used to assess environmental mobility was the SPLP test (SW846 MTD 1312)[14] as this leaching test closely represented potential leaching in the proposed on-site placement environment for treated material. The SPLP method approximates leaching conditions in the field resulting from precipitation because the SPLP leaching fluid consists of a mixture of inorganic acids (sulfuric and nitric) in water and was formulated to simulate acid precipitation. The treatability studies were successful in demonstrating that S/S technology could effectively treat the ACW soils and meet performance targets, at an acceptable cost. The reader should be aware that other reagent doses were tested during treatability tests, some lower in cost. However, they all failed to adequately treat one or more of the contaminents of concern. The formulation shown in Table 5 were the only successful ones. Details of formulations and test results are provided in literature cited (6,9,12). Note that the actual formula used for remediation is also provided in Table 5 for reference. It is discussed further as part of the description under construction.

REMEDIAL DESIGN, BIDDING AND CONSTRUCTION

Following completion of successful treatability studies in 1997, the US EPA, in cooperation with the State of Tennessee, Department of Environment and Conservation, developed a performance based remedial action design and bid package for the main processing area in 1998 . The State of Tennessee bid the project and made award to the lowest price qualified bidder, IT Group (as IT/OHM Corporation). Major cost components from the successful bid are shown in Table 7.

The contractor mobilized on the site in the spring of 1999. The contractor set up a standard pug mill treatment train including power screens to remove oversize rubble, three silos to dispense measured quantity of reagents, a large high capacity pug mill, and untreated and treated soil storage areas. The treatment train was set up on a fresh gravel cover over a packed earth base. A water treatment system was also installed including an oil/water separator to remove creosote and a large lined holding lagoon to store contaminated water prior to treatment and discharge to the local POTW (Public Owned Treatment Works).

Initial activities on-site included removal of concrete foundations and old railroad ties, installation of a HDPE, (High Density Polyethylene).cutoff wall, and cutting drainage trenches across the area to be remediated. The cutoff wall was keyed into the underlying clay to prevent water in an adjacent pond from infiltrating into the contaminated soil excavation. The railroad ties were cut up to prevent future use and sent off-site for disposal. Contaminated concrete foundations were broken into small blocks and incorporated into the S/S treated soil monolith under supervision of Tennessee and EPA.

Prior to excavating and treating the contaminated soil, it was necessary to drain and remove the water and oil that were perched above the confining clay, which occurred at a depth of about three to five feet. Parallel trenches were cut on strike down to the top of the clay, the creosote oil and water were then pumped to an oil/water separator, the creosote stored for off-site disposal and the water sent to the holding lagoon. Due to an unusually hot and dry summer season, most of the water evaporated from the holding lagoon, reducing treatment costs. The creosote recovered also turned out to be a far smaller volume than expected.

Following the draining of water and creosote, the soils were excavated to the top of the clay, screened, treated with reagents in the pug mill, and returned to the excavation where they were compacted and allowed to cure in place to form one continuous monolith. Soils from several other identified small hot spots on-site were also analyzed against the soil action levels and as necessary removed, treated, and disposed with the rest of the treated soils. The S/S treatment specifications are shown in Table 8. Upon completion, 46,700 cubic yards (80,700 tons) of contaminated soil had been treated and disposed of on-site. The entire remediation operation proceeded very smoothly with only a few minor change orders required. The S/S formula used (Table 5) by IT Corporation for this remediation was 5% Portland cement, 4.5% fly ash, and 1.3% powdered carbon, all as weight percents of the untreated soil. This is very similar to the $39 treatability test formulation from Table 5, but reflects that IT Corporation was able to reduce the quantity of reagents used, thereby lowering costs, which likely contributed substantially to the contractor's being able to submit the lowest price bid and obtain the contract. By far, the most costly reagent was the powdered carbon. The formula used for the remediation contained 1.3% powdered carbon in contrast to 2.0% used for the $39 formulation in Table 5. It is postulated that the reason for success of the remediation formula, while less expensive formulas failed during treatability tests, is due to the homogenization of contaminated soils that occurred during excavation, screening, and stockpiling of soils prior to treatment during remediation. This had the effect of reducing contaminent concentration in the most contaminated soils. During treatability tests, the most contaminated soils were selected for testing to assure that all soils could be successfully treated.

Following completion of the S/S treatment and placement of all the treated soil back into the excavation as a solid monolith, the treated material was capped with a geosynthetic clay liner (GCL) followed by two feet of subsoil and topsoil. The site was then seeded and now blends into the natural slopes and terrain around the site. Since the work was completed, EPA and the State have received inquiries from the local utility district regarding acquiring the property.

CONCLUSION

This discussion illustrates that highly contaminated wood preserving sites containing creosote, pentachlorophenol, and dioxins can be successfully remediated at very moderate cost, through use of careful site characterization, appropriate soil action levels, site-specific treatability studies, use of innovative remedial designs, and proper construction. To the best of the authors' knowledge, this remains the lowest unit cost for treatment and remediation of a dioxin contaminated site. The project was completed in less than a year for a complete (mobilization through demobilization) cost of about \$64/cubic yard (\$40/ton) of untreated soil.

FUTURE OPERATIONS AND MONITORING

Future operations include O&M of the cap and monitoring of groundwater. The major O&M activities include mowing of the cap and repair should any erosion damage, or loss of vegetative cover, occur to the cap. The remediation included gentle slopes and swales to remove precipitation and use of grass species hardy to the area. Thus, except for unusual storm events, no weather related damage should occur to the cap.

Groundwater monitoring will occur twice a year for at least five years. On-Site wells are completed in both the shallow alluvial aquifer screened at depths of 12 to 30 feet below surface (and below the shallow clay layer) and into the Fort Pillow aquifer screened at depths of 50 to 127 feet. Off-site wells are also completed into both aquifiers. Wells in both aquifers are spaced not only up gradient and down gradient, but also on the sides to provide a complete picture. It is too early yet to make any observations regarding post source area remediation changes in groundwater quality. However, a five year review will be conducted in the future.

Table 1. ACW Site History

Activity	Date
Wood Treating Operations	1930 to 1981
Site Discovery	1981
EPA Emergency Removal Action	1983
Site Listed	1984
Site RI/FS[a.]	1988
Focused RI[b.]	1993
Focused Risk Assessment	1996
Record of Decision	1996
S/S Treatability Studies Completed	1997
Design and Bid Package Completed	9/98
Remediation Contract Awarded	3/99
Construction Completion	Spring 2000

a. RI/FS means Remedial Investigation/Feasibility
b. RI means Remedial Investigation Study

Table 2. ACW 1988 FS alternatives

Remedy/Technology	Estimated Cost Millions $
Secure Site and Monitor	0.3
Excavate Soil to 120 feet.	3,700
Cap and Monitor	25
Excavate Soil to 5 feet	157

Solidification of Soils to 2 feet	34
Incineration	260
Soil Washing	100
Solvent Extraction	127
Bioremediation	76

Table 3. Soil Action level goals [a] as determined for the American Creosote Site, Jackson, TN[13]

Contaminant	Soil Action Level[b] (mg/kg)
Arsenic	225
Benzo(a)Pyrene	41.5
Dibenzo (a,h,)anthracene	55.0
Pentachlorophenol	3000
Dioxins TCDD-TEQ	0.0025

a) Level of contaminant in soils at, or above which, remedial action is required

a) Based on lifetime cancer risk future adult worker, $1X10^{-4}$ risk

Table 4. Comparison of ACW cleanup factors

Parameter	1988 RI/FS[a.]	1996 ROD[b.], Implemented 1999
Remedial Technology	Solidification	Solidification
Basis for Cleanup	Residential	Industrial
Soil Volume, Cu. Yds.	194,000	45,000
Average Dept, Feet	2	2
Estimated Cost, $Millions	34.4	4.5

a) RI/FS means Remedial Investigation/Feasibility Study
b) ROD means Record of Decision

Table 5. Successful stabilization formulas for the ACW site[9]

Reagent Additions (wt/wt of untreated soil)	Treatability Test Formula Cost $39[a]	Treatability Test Formula Cost $62[a]	Remediation Formula $17[a]
Untreated Soil	1.0	1.0	1.0
Type 1 Portland Cement	0.2	--	0.05
Class F Fly Ash	0.1	–	0.045
Activated Carbon	0.02	–	0.013
STC P-1[b]	–	0.2	-
STC P-4[b]	--	0.06	-

Dilution Factor[c] (Water Excluded)	1.32	1.26	1.108

a) Estimated cost of formula to treat one ton of raw soil
b) Propriety Reagent, STC Remediation, Inc., Scottsdale, Arizona
c) Weight of untreated soil plus reagents divided by the weight of untreated soil

Table 6. Selected ACW treatability study results[9]

Parameter	**Units**	**Untreated**	**Treated $39/Ton[a]**	**Treated $62/Tona**	**Target**
Pentachlorophenol					

Total	mg/kg	200	-	-	-
SPLP (pH)	μg/L	8,200 (7.0)	120 (11.8)	12 (11.8)	200
Dioxins (TEQb)					
Total	μg/kg	50	-	-	-
SPLP (pH)	pg/L	320 (7.0)	12 (11.8)	14 (11.8)	30
PAHs (BaP EQ[c])					
Total	mg/kg	29	-	-	-
SPLP (pH)	μg/L	2.8 (7.0)	<2.8 (11.8)	<2.8 (11.8)	10
Physical Properties[d]					
UCS[e]	psi	-	1,435	1,240	>100
Permeability	cm/sec	-	1.1×10^{-6}	4.1×10^{-7}	$<1 \times 10^{-6}$

a) Cost of reagent only per ton of untreated soil
a) All concentrations expressed as equivalents of 2,3,7,8 TCDD[15]
a) All concentrations expressed as Benzo(a)Pyrene potency estimate equivalents[16]
a) 28 day cure time
a) Unconfined compressive strength

Table 7. Major bid cost components of the remedial action at the American Creosote site, Jackson, Tennessee

Item	**Cost Per Unit**	**Total $1,000**
Mobilization and Documents	-	142
Demolition/Debris	-	34
NAPL Recovery[e]	System	124
Cutoff Wall	$9.00 Lin. Ft.[b]	20
Drainage Trenches	$14.90 cy[c]	75
Excavate, Treat and Replace Soil	$44.25 cy[c]	1996
Water Treatment	$ 0.68 gal[d]	20
Creosote Disposal	$ 3.05 gal[d]	47
CAP (GCL[a] plus 2 ft. soil)	$50,460 .00 Acre	363
Site Restoration and Demobilization	-	55
Other	-	10
Total		2,886

a) Geosynthetic clay liner
b) Linear foot
c) Cubic yard
d) Gallon U.S.
e) NAPL means Non Aquaous Phase Liquid

Table 8. Solidification/stabilization specifications for remediation of the American Creosote site

Parameter	**Average All Treated**	**Maximum Any Batch**[b]	**Method**	**Results Achieved**[d]
Leaching Properties[a]				
Arsenic	<50 μg/L	<75 μg/L	SW8467061	16.3
PAHs[e] B(a)P Potency Estimate	<10 μg/L	<15 μg/L	SW8468270	< 1.0
Dibenzo(a,h) Anthracene	< 4.4 μg/L	< 6.6 μg/L	SW8468270	< 0.8
PCP	<200 μg/L	<300 μg/L	SW8468270	39.4
Dioxins TCDD-TEQ	< 30 pg/L	< 45 pg/L	SW8468290	1.29

Physical Properties				
Permeability	$<1X10^{-6}$ cm/sec	$<1X10^{-5}$ cm/sec	ASTM D5084	$1.02X10^{-6}$ cm/sec
UCS[c]	<100 psi	>80 psi	ASTM D1633	222 psi
Volume Increase	< 35 percent			~ 10 percent

a) Synthetic precipitation leach procedure, EPA SW846, Method 1312
b) Batch size 500 cubic yards
c) Unconfined compressive strength
d) Average of all performance samples collected during remediation
e) Polycyclic aeromatic hydrocarbons

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Solidification/Stabilization for Remediation of Wood Preserving Sites: Treatment for Dioxins, PCP, Creosote, and Metals

Author: Edward R. Bates
E. Sahle-Demessie
Douglas W. Grosse
National Risk Management Research Laboratory
U.S. Environmental Protection Agency

Abstract

This article discusses the use of solidification/stabilization (S/S) to treat soils contaminated with organic and inorganic chemicals at wood preserving sites. Solidification is defined for this article as making a material into a free standing solid. Stabilization is defined as making the contaminants of concern non mobile as determined from a leaching test. S/S then combines both properties. For more information on S/S in general the reader should refer to other publications (Conner, 1990; USEPA 1993a; Wiles, 1989) as this article addresses only wood preserving sites and assumes basic knowledge of S/S processes. For a more general discussion of wood preserving sites and some other remedial options, the reader may wish to refer to a previous EPA publication (EPA, 1992a).

This article includes data from the successful remediation of a site with mixed organic/inorganic contaminants, remediation of a site with organic contaminants, and detailed treatability study results from four sites for which successful formulations were developed. Included are pre and post treatment soil characterization data, site names, vendor names (in some cases), treatment formulas used (generic and proprietary), costs, recommendations and citations to more detailed references. The data presented indicate that Dioxins, pentachlorophenol (PCP), creosote polycyclic aromatic hydrocarbons (PAHs) and metals can be treated at moderate cost by the use of S/S technology.

Introduction

Solidification/stabilization (S/S) immobilizes contaminants rather than removing the contaminants. Solidification is defined for this article as making a material into a free standing solid. Stabilization is defined as making the contaminants of concern non mobile as determined from a leaching test. S/S then combines both properties. The remediation and treatability studies described in this article all used Portland Cement as part of the reagent mix producing a solid monolithic, treated product. For a general description of S/S processes and applications, the reader may wish to refer to other publications (Connor, 1990, USEPA 1993a; Wiles, 1989).

Remediation of the Selma Pressure Treating Site

In 1990 the United States Environmental Protection Agency (US EPA) conducted a successful Superfund Innovative Technology Evaluation (SITE) Demonstration of an innovative S/S technology at the Selma Pressure Treating (SPT) site in Selma, California (national priority listed Superfund site). The technology developed by Silicate Technology Corporation of Scottsdale, Arizona (now known as STC, Inc.) stabilized soil contaminated with PCP and chromated copper arsenate (CCA)(Bates, et al, 1991; U.S. EPA, 1992b).

Following this successful field test the remediation of the SPT site was bid and awarded. In 1993-1994 the site was remediated by Chem Waste Management using the STC technology. PCP and CCA were the target contaminants. A previously published article provides more details on the design, construction, and cost of this innovative remediation (Bates and Lau, 1995). Exhibit 1 summarizes the soil characteristics before and after remediation. Dioxins/furans were not designated target contaminants during this remediation, however, several months following the remediation, EPA did arrange to have archived samples from the remediation analyzed for total and leachable dioxins/furans. These results are presented in Exhibit 2 with PCP concentration measurements made at that time. The data in Exhibits 1 and 2 document substantial reductions in the mobility of both the inorganic and organic contaminants of concern including dioxin. Referring to Exhibit 2 and the synthetic precipitation leach procedure (SPLP, SW846, MTD 1312) the data show more than a 99 percent reduction in the mobility of both PCP and dioxin.

Treatability Studies

Following successful remediation of the SPT site, the EPA National Risk Management Research Laboratory (NRMRL) became involved in assessing the applicability of a number of technologies for possible application to the remediation of wood preserving sites. Consequently, a number of treatability studies were conducted including S/S tests using formulations on soils from several Superfund sites including:

McCormick and Baxter (MCB), Stockton, California;
American Creosote Works (ACW), Jackson, Tennessee;
Texarkana Wood Treating (TWT), Texarkana, Texas; and
RAB Valley Wood Preserving Site (RAB) near Panama, Oklahoma.

The primary objective for all the S/S studies was to develop formulations that could treat all contaminants of concern, which included dioxins, PCP, and creosote PAHs to meet all treatability criteria. For the ACW site a subsequent remedial design treatability study also focused on minimizing the formula cost while still meeting the treatment criteria. For most tests the treatment criteria (targets)were established in advance and are shown in Exhibits 4 through 8, which also depict the treatment results for each site. The reader should be aware that two to three rounds of treatability tests were conducted for each site in order to develop cost effective formulations that could meet all the chemical and physical treatment criteria. Although toxicity characteristic leaching procedure tests (TCLP, SW846, MTD 1311) were run on successful formulations, the primary test used to assess environmental mobility was the SPLP test. The SPLP test more closely represents potential leaching in the proposed on-site placement for treated material resulting from precipitation because the SPLP leaching fluid consists of a mixture of inorganic acids in water and was formulated to simulate acid precipitation.

Formulations Used - Exhibit 3 describes the formulations developed and used in these studies that met all treatment criteria. Two to three rounds (or tiers) of treatability tests using generally three to six formulations per round were conducted for each site-specific treatability test. Exhibit 3 presents only the formulations that were able to meet treatability study objectives. However, much can also be learned from formulations that failed. The reader may wish to reference the cited documents for more information on performance of all formulations tested. Generally, the performance criteria most difficult to meet were low leachability of PCP and low permeability properties ($1x10^{-6}$cm/sec).

Exhibit 3 shows six successful formulations: two for the ACW site, one proprietary to STC and one generic; two for the TWT site, one proprietary to OHM and one generic; and one proprietary to STC for both the McCormick Baxter and RAB Valley sites. The cost of the S/S formula to treat one ton of raw soil ranged from $39 to $66, with an average cost of approximately $53. These are the costs for the chemical reagent in the formulations only. Transportation and all other site-specific costs such as excavation, mixing, replacement on-site (or disposal off-site), performance verification testing, installation of final cover, design and oversight costs, and any other site-specific remediation cost are not included. These other costs are site and design specific and influenced by the volume of soil and the specific treatment criteria. In the authors' experience the total of all these site specific costs may range from $30 to more than $100 per ton of raw soil (excluding the cost of the treatment formula).

Exhibit 3 includes four proprietary formulations by STC and OHM, but also includes two generic formulations containing no proprietary materials. Proprietary formulation names are included only for the purpose of describing the work performed. Exhibit 3 also includes the dilution factor due to reagent addition, which ranged from 1.2 to 1.35. These dilution factors were used in determining the percent reduction of contaminants in the leaching tests. The actual measured concentration of a contaminant in a leachate was multiplied by the dilution factor of the reagents added, to produce an adjusted (not shown in Exhibits) after treatment contaminant concentration. This adjusted contaminant concentration was then compared to the leachate from the untreated soil to produce a percent reduction so that no credit was given for the effects of dilution.

<u>Stabilization of PCP</u> - Of all the target contaminants treated, PCP was the most difficult to stabilize and meet treatment criteria. Exhibit 4 provides the results from four treatability tests in which PCP was successfully stabilized. However, the reader should be aware that there were also many formulations tested that failed to adequately stabilize PCP. For example, the entire first round of formulas tested for the TWT site failed to meet the PCP criterion of 200 μg/L or less in SPLP extracts. This was in spite of the fact that formulations that had been successful on ACW soils were included in the first round of the TWT test. This illustrates the important point that each site is unique and it is essential to conduct treatability tests for each specific site. Formulations that were demonstrated to work well on other sites may not work well on a new site.

Exhibit 4 contains leachate data for both TCLP and SPLP test methods. (Reference U.S. EPA 1995a for Leaching Method

Descriptions). The final leachate pH is provided in addition to the PCP concentration. Data in Exhibit 4 clearly illustrate that leachate results for the two leaching methods can differ dramatically. In the authors' experience, the SPLP method usually extracts far more PCP than the TCLP method. This holds true for both the untreated and the treated soil. The difference often approaches or exceeds a factor of ten. Further, it can be argued that the SPLP method more closely approximates leaching conditions in the field resulting from precipitation because the SPLP leaching fluid consists of a mixture of inorganic acids in water and was formulated to simulate acid precipitation. Thus, the selection of the leaching method may have a substantial impact on assessing the risk to surface or groundwater posed by leaching of either untreated or treated material. However, it should be noted that not all PCP in soil has the same leaching potential. Examination of untreated soil leachates reveals that sometimes lower total concentrations of PCP in soil yield higher leachate concentrations. This may be due in part to the fact that PCP is a weak acid with solubility dependent partly on the degree of protonation and that solubility may be equilibrium controlled. Thus, other chemicals in the soil, such as humic acids may affect the solubility of the PCP. It also may be that the PCP is more tightly adsorbed to organic constituents in some soils and thus not easily extracted by the leaching fluid. Overall Exhibit 4 indicates that PCP in soil was successfully treated by S/S, by at least one formulation, to below target level concentrations at four sites. Percent reductions generally ranged from 97 to over 99 (85% in one case), after adjusting to eliminate any effect of dilution by the treatment reagents. Note that in exhibits 4,5, and 6 the pH of the final leaching solution is alkaline impacting the solubility of the contaminants.

Stabilization of Dioxins - The results from tests to stabilize dioxins in soils from the four wood preserving sites are presented in Exhibit 5. Data for both TCLP and SPLP are provided along with the pH of the final leachate solutions. The total values of dioxins in soils from the four sites ranged significantly. The dioxins were a contaminant in the PCP wood preserving solutions. In the authors' experience, the range of 9 to 50 μg/L 2,3,7,8 TCDD toxicity equivalents (TCDD-TEQ) represents most wood preserving sites where PCP was used. An explanation for calculating dioxin TEQ values is presented in a previous EPA publication (U.S. EPA 1989).

Similar to PCP, the dioxins in the untreated soil appear to be much more soluble in the SPLP leachate than in the TCLP leachate. However for dioxins, the factor often approaches or exceeds two orders of magnitude (TWT, MCB, RAB) for the untreated soil. In the treated soil the differences are not clear or consistent. For example, the data for the MCB and RAB sites show higher dioxin concentrations in the TCLP extract while the TWT formulations contained slightly higher dioxin concentrations in the SPLP extract for one formulation and are unclear regarding the second formulation.

Overall, the data in Exhibit 5 indicate successful stabilization of dioxins as measured by SPLP extracts with reductions ranging from 95 to over 99 percent, after adjusting for dilution by reagents. Target concentration levels were met for dioxins in SPLP leaches for all sites by use of at least one of the formulations. The data for TCLP extracts are more limited and no general pattern is evident. For the TWT formulas, dioxins in the TCLP extracts were below detection limits both before and after treatment; MCB shows a 72% decrease following treatment; and RAB shows a substantial increase following treatment. It is interesting to note that the same treatment formula was used for the MCB and RAB soils. This again demonstrates the need for site-specific treatability tests, since site-specific soil characteristics can produce substantially different impacts on performance of a treatment formulation, and the impact of specific soil characteristics on treatment performance are not predictable.

Stabilization of PAHs - A summary of PAH data from the treatability tests is provided in Exhibit 6. Data are provided as a benzo(a)pyrene potency estimate [B(a)P potency estimate] and on the sum of all detected PAHs. An explanation on calculation of the benzo(a)pyrene potency estimates is provided in a previous EPA publication (U.S. EPA 1993b). The references cited in Exhibit 6 provide extensive data showing performance on each individual detected PAH.

B(a)P potency estimates are often used to obtain an overall assessment of the risk from PAH compounds. The principal observation on B(a)P potency estimates in Exhibit 6 is that these compounds were only slightly leachable before treatment and are less leachable after treatment, due to their low water solubility; concentrations were often below detection limits. There appears to be a slight, but consistent, tendency for the SPLP extraction procedure to produce higher concentrations from the untreated soil than was the case for the TCLP extraction procedure. In all cases the SPLP extract after treatment met the treatability criteria of having less than a 10 μg/L B(a)P potency estimate.

Since B(a)P potency estimates were at such low levels, the total (sum) of all detected PAHs are also included in Exhibit 6. Generally, the TCLP test procedure produced slightly higher concentrations of total detected PAHs than the SPLP for untreated soils (5 of 6 cases) while SPLP produced slightly higher concentrations in treated samples (3 of 4 cases). However, the principal message from looking at total detectable PAHs is that S/S treatment successfully reduced the total detected PAHs by over 90% in leachates, in all except one case which was 84%. However, SPLP leachates met target levels for all three sites for which target levels had been established.

Stabilization of Metals - Stabilization of metals was not a primary goal of the treatability tests discussed in this article. However, the results for metal treatment are presented in Exhibit 7 because leachable metal data were collected for three of the sites. However, the reader is cautioned not to draw too many conclusions from these data as the concentrations are quite low, both before and after treatment, and no emphasis was placed on developing formulations for metal stabilization in these particular tests. The data in Exhibit 1, which was a full scale remediation that targeted metals, is considered more indicative of the S/S to treat metals at wood preserving sites than the data presented in Exhibit 7.

Physical Properties of Treated Soils - Exhibit 8 summarizes the principle physical properties achieved in the treatability tests. The treatability criteria of over 100 psi unconfined compressive strength and a permeability of less than $1x10^{-6}$ cm/sec were achieved by all formulations listed. The reader is cautioned, however, on two points. First, these criteria were set for the treatability tests and do not necessarily reflect the final goals for site remediation. Second, not all of the formulations tested were able to meet these criteria. Many failed to meet one, or both; however, the data do indicate that it was possible to develop formulations for each of these four sites that could meet these treatment criteria.

Case Study - Remediation of the American Creosote Works Site

The ACW site encompasses 60 acres of marshy flood plain along the Deer River just southwest of Jackson, Tennessee. The facility treated wood from the 1930's to 1981 using both creosote and PCP. Surface soils in an approximate eight acre main process and drip tracks area, consisting primarily of sands and silts, were contaminated by creosote, PCP, and dioxins. The main process area is underlain by a confining clay layer at a depth of approximately two to five feet limiting the depth to which soils were contaminated.

In 1996 the USEPA completed a focused risk assessment for the ACW site. Based on a future industrial use scenario and a defined risk of $1X10^{-4}$, soil action levels were defined for contaminants of concern as shown in Exhibit 9. Later that same year the USEPA, with concurrence from the State of Tennessee, signed a Record of Decision which called for remediation by excavation, ex-situ treatment by S/S, and replacement of treated soil under a cap. Following completion of the remedial design treatability study in 1997, the USEPA, in cooperation with the State of Tennessee, developed a performance based remedial action design and bid package in 1998 for the main processing area. In 1999 the State of Tennessee bid the project and awarded the contract to the IT Group (as IT/OHM Corporation) and the remediation project commenced in the spring of 1999. As of the end of December 1999, excavation, treatment, and on-site disposal of treated soils was complete and construction of the cap over the treated material was well advanced. Vendor records show that 46,700 cubic yards (80,700 tons) of contaminated soil were excavated, treated, and replaced into the excavation area. The S/S treatment specifications are shown in Exhibit 10, while the major remediation cost elements are shown in Exhibit 11. Note that the bid cost to excavate, treat, and replace soils was $44.25 per cubic yard (measured as untreated soil in place before treatment) and the total bid costs for all activities averaged over the estimated 45,000 cubic yards came to just over $64 per cubic yard. The treatment formulation developed by IT/OHM Corporation and used for this successful treatment of dioxins, PCP and creosote was 1.3% powdered carbon, 5% Portland cement, and 4.5% fly ash, all determined as weight percents of the untreated soil. This project demonstrated that a highly contaminated wood preserving site containing dioxins, PCP, and creosote, can be remediated at moderate cost by using S/S technology.

Conclusion

During two full scale remediations and various treatability tests on several wood preserving sites, it has been documented that S/S formulations can be developed that meet all physical properties and chemical stabilization (immobilization) goals. The cost for the chemical formulations in the treatability tests ranged from $39 to $66 (chemicals only). Complete costs for remediation are highly dependent on site-specific factors, but could be expected to range from $40 to $100 per ton ($60-$120 per cubic yard) of untreated soil.

TCLP and SPLP leaching tests often produce dramatic differences in concentrations of contaminants in leachates for both untreated and treated soil samples. For both PCP and dioxins, the SPLP leach procedure produced higher concentrations in leachates than did the TCLP leach procedure, thus careful consideration should be given to selection of the leaching procedure to be used in evaluating leaching properties of either treated or untreated soils. In the authors opinion, the SPLP appeared to be a better test method to measure the effectiveness of the S/S treatment technology. The concentrations of contaminants of concern in SPLP leachates for S/S treated soils were generally 95 to 99% less than in SPLP leachates from untreated soils.

Following development of successful formulations during treatability tests for the ACW site in Jackson, Tennessee, this site remediation was bid by the State of Tennessee. In 1999 a contract was awarded for remediation of this site including S/S of an estimated 45,000 cubic yards of highly contaminated soil. The bid price for excavation, S/S treatment, and replacement (including reagent costs and performance sampling) was $44.25 per cubic yard while total project bid costs including the draining, collection, treatment, and disposal of a water and creosote NAPL and placement of a cap came to slightly over $64 per cubic yard if divided by the 45,000 cubic yards of contaminated soil. By the end of December 1999, excavation, treatment, and on site disposal of treated soils was complete with vendor records showing 46,700 cubic yards (80,700 tons) of contaminated soil successfully treated.

Exhibit 1 Remediation of the SPT Site①

Parameter	Measurement Method②	Untreated mg/Kg (mg/L)	Action Level③ mg/Kg (mg/L)	Treatment Criteria④ mg/Kg (mg/L)	Actual Performance mg/Kg (mg/L)		
					Samples⑤	Mean	High
As /Total	7060	1500	25	-	-	-	-
As TCLP	1311 & 6010	10	5.0	5.0	543	<0.1	0.2
PCP Total	8040	3000	17	-	-	-	-
PCP TCLP	1311	3.1	0.300	0.300	543	<0.1	0.21
PCP SPLP	1312	39	-	-	-	<0.1	-
Cr Total	6010	2000	3910	-	-	-	-
Cr(Total) via TCLP	1311 & 6010	1.0	0.5	0.5	543	<0.1	0.3
Cr Hexavalent via TCLP	1311 & 7197	<0.1	0.5	0.5	543	<0.1	0.1
Cu Total	6010	1500	31800	-	-	-	-
Cu via TCLP	1311 & 6010	5.0	10.0	10.0	543	<0.1	1.1
Permeability	ASTM D5084	-	-	$<1X10^{-7}$ cm/sec	>300	All Passed	

Unconfined Compressive Strength	ASTM D2166	-	-	>15 psi at 5 days 100 psi at 28 days	>300	All Passed

① Bates and Lau, 1995
② All methods per EPA 1995 (SW846) except ASTM.
③ Action level is the contaminant level in untreated soil, at or above which, treatment (action) is judged to be necessary.
④ Treatment criteria is the targeted value to be achieved by treatment.
⑤ Total number of samples collected and analyzed.

Exhibit 2 Dioxin and PCP Analyses on Archived Samples from Remediation of the SPT Site (Area C)①

Parameter	Measurement Method②	Mean③ Untreated	Mean③ Treated
Dioxin/Furan (TCDD-TEQ)			
Total	8280	12 μg/Kg (ppb)	-
TCLP	1311, 8290	28 pg/L (ppq)	<0.025 pg/L (ppq)

SPLP	1312, 8290	144 pg/L (ppq)	<0.01 pg/L (ppq)
PCP			
Total	8270	1100 mg/Kg (ppm)	-
TCLP	1311, 8270	3.1 mg/L (ppm)	<0.1 mg/L (ppm)
SPLP	1312, 8270	38.5 mg/L (ppm)	<0.1 mg/L (ppm)

① EPA, 1996a
② All methods per EPA 1995 (SW846)
③ Average of all samples analyzed.

Exhibit 3 Stabilization Formulas for Treatability Tests ①

Reagent	Site Name					
Wt/Wt of Untreated Soil	ACW⑥		TWT⑦		MCB⑧	RAB⑧
Formula Cost② $	39	62	66	54	50	50
Vendor Name③	STC	STC	OHM	OHM	STC	STC
Untreated Soil	1.0	1.0	1.0	1.0	1.0	1.0
Type 1 Portland Cement	0.2	-	0.1	0.2	0.08	0.08
Class F Fly Ash	0.1	-	0.1	0.1	-	-
Activated Carbon	0.02	-	0.02	0.05	-	-
OHM AR-8④	-	-	0.02	-	-	-
STC P-1⑤	-	0.2	-	-	-	-
STC P-4⑤	-	0.06	-	-	0.12	0.12
Water Added	?	?	0.15	0.2	?	?

Dilution Factor⑨ (Water Excluded)	1.32	1.26	1.24	1.35	1.2	1.2

① Weight ratio of reagent to untreated soil
② Cost of Formula to Treat one Ton of Raw Soil
③ OHM = OH Materials, Findley, Ohio
STC = STC, Inc., Scottsdale, Arizona
④ Proprietary OHM Reagent
⑤ Proprietary STC Reagent
⑥ EPA, 1997 b., Tier 1
⑦ EPA, 1997 a., Tier 2
⑧ EPA, 1998, Vendor C, Round 2
⑨ Weight of untreated soil plus reagents divided by the weight of untreated soil

Exhibit 4 Stabilization of Pentachlorophenol in Treatability Tests

Reagent	Site Name					
	ACW⑤		TWT⑥		MCB⑦	RAB⑦
Formula Cost $/Ton Raw Soil	39	62	66	54	50	50
Untreated						
Total mg/kg	200	200	270	270	347	1210
TCLP μg/L (pH)	--	--	690 (5.0)	690 (5.0)	360 (5.0)	2400 (5.2)
SPLP μg/L (pH)	8200(7.0)	8200 (7.0)	7200 (7.2)	7200(7.2)	13000(6.8)	3900 (7.0)

Treated						
TCLP µg/L (pH)	-	-	5.1 (6.4)	77 (8.1)	<1.0 (5.9)	21 (6.6)
SPLP µg/L (pH)	120(11.8)	12 (11.8)	67 (12.2)	150(12.5)	<1.0(11.2)	24 (11.2)
Target SPLP µg/L	200	200	200	200	-	-
% Reduction④ TCLP	-	-	99	85	>99	99
SPLP	98	>99	99	97	>99	>99

① EPA, 1997 a., Tier 2

② EPA, 1997 b., Tier 1
③ EPA, 1998, Vendor C, Round 2
④ Percent Reduction values have been adjusted to eliminate the effect of dilution by reagents added (see dilution factor Exhibit 3)

Exhibit 5 Stabilization of Dioxins① in Treatability Tests

Reagent	Site Name			
	ACW②	TWT③	MCB④	RAB④

Formula Cost $/Ton Raw Soil	39	62	66	54	50	50
Untreated						
Total µg/kg	50	50	8.75	8.75	14	10
TCLP pg/L (pH)	9.8 (5.0)	9.8 (5.0)	<14 (5.0)	<14 (5.0)	110 (5.0)	23 (5.2)
SPLP pg/L (pH)	320 (7.0)	320 (7.0)	6200 (7.2)	6200(7.2)	9800(6.8)	460 (7.0)
Treated						
TCLP pg/L (ppq) (pH)	-	-	<17 (6.4)	<17 (8.1)	26 (5.9)	530 (6.6)
SPLP pg/L (ppq) (pH)	12 (11.8)	14 (11.8)	29 (12.2)	12 (12.5)	11 (11.2)	17 (11.2)
Target SPLP pg/L (ppq)	30	30	30	30	-	-
% Reduction⑤ TCLP	-	-	NC	NC	72	Increase
SPLP	95	95	>99	>99	>99	96

① All concentrations expressed as equivalents of 2,3,7,8-TCDD (EPA 1989)
② EPA, 1997 a., Tier 1
③ EPA, 1997 b., Tier 2
④ EPA, 1998, Vendor C, Round 2
⑤ Percent Reduction values have been adjusted to eliminate the effect of dilution by reagents added (see dilution factor Exhibit 3)
NC = Not Calculated

Exhibit 6 Stabilization of PAHs① in Treatability Tests

Treatment Characteristic	Site Name					
	ACW②		TWT③		MCB④	RAB④
Formula Cost $/Ton Raw Soil	39	62	66	54	50	50
Untreated						
Total mg/kg	29	29	36	36	55	75
TCLP μg/L (pH)	2.8 (5.0)	<2.8 (5.0)	<0.9(5.0)	<0.9(5.0)	<2.8(5.0)	<2.8 (5.2)
SPLP μg/L (pH)	2.8 (5.0)	2.8 (7.0)	11 (7.2)	11 (7.2)	14 (6.8)	<14 (7.0)
Treated						
TCLP μg/L (pH)	-	-	<3.6 (6.4)	3.6 (8.1)	<2.8(5.9)	<2.8 (6.6)
SPLP μg/L (pH)	<2.8(11.8)	<2.8(11.8)	<1.0(12.2)	<0.8(12.5)	<2.8(11.2)	<5.5(11.2)
Target SPLP μg/L	10	10	10	10	-	-
% Reduction⑤ TCLP	-	-	NC	Increase	NC	NC
SPLP	NC	NC	89	>90	>76	NC
Total All Detected PAHs Untreated TCLP μg/L	850	850	2100	2100	110	920
Treated TCLP μg/L	-	-	70	60	<1.0	66
Untreated SPLP μg/L	510	510	1400	1400	190	690
Treated SPLP μg/L	1.2	<1.0	105	168	1.3	54
%Reduction⑤ TCLP	-	-	96	96	99	91
SPLP	>99	>99	91	84	99	91

① All concentrations expressed as Benzo(a)Pyrene potency estimate(EPA 1993b), except as noted
② EPA, 1997 a., Tier 1
③ EPA, 1997 b., Tier 2
④ EPA, 1998, Vendor C, Round 2
⑤ Percent reduction values have been adjusted to eliminate the effect of dilution by reagents added (see dilution factor Exhibit 3)
NC = Not calculated

Exhibit 7 Stabilization of Metals① $\mu g/L$ in Treatability Tests

Treatment Characteristic	Site Name						
	ACW④			MCB⑤		RAB⑤	
Formula Cost $/Ton Raw Soil	Untreated	39	62	Untreated	50	Untreated	50
TCLP② (pH)	-	-	-	5.0	5.9	5.2	6.6
Arsenic	-	-	-	191	64	<20	<20
Chromium	-	-	-	<20	<20	<20	<20
Copper	-	-	-	610	62	26	<20
Lead	-	-	-	<10	29	198	31
Zinc	-	-	-	1190	441	3690	9
SPLP③ (pH)	7.0	11.8	11.8	6.8	11.2	7.0	11.2
Arsenic	<20	<20	<20	189	<20	<20	<20
Chromium	<20	60	70	27	26	<20	<20
Copper	22	<20	<20	211	27	<20	<20
Lead	24	<10	14	37	<10	15	<10
Zinc	418	<50	<50	579	<50	666	<50

① Metals were not a target for treatment in these studies, thus results should not be interpreted as the best achievable
② EPA SW 846 Method 1311
③ EPA SW 846 Method 1312
④ EPA 1997 a., Tier 1
⑤ EPA 1998, Vendor C, Round 2

Exhibit 8 Physical Properties of Treated Soils① in Treatability Tests

Property	Site Name					
	ACW③		TWT④		MCB⑤	RAB⑤
Formula Cost $/Ton Raw Soil	39	62	66	54	50	50
Unconfirmed Compressive Strength (psi)	1435	1240	340	620	170	100
Goal (psi)	>100	>100	>100	>100	-	-
Permeability (cm/sec)	1.1×10^{-6}	4.1×10^{-7}	1.4×10^{-7}	5.6×10^{-7}	2.2×10^{-7}	3.1×10^{-7}
Goal (cm/sec)	$<1 \times 10^{-6}$	$<1 \times 10^{-6}$	$<1 \times 10^{-6}$	$<1 \times 10^{-6}$	-	--
Dilution Factor②	1.32	1.26	1.24	1.35	1.2	1.2

① All values after 28 day cure

② Weight of Reagent plus soil divided by weight of untreated soil. Water added not included

③ EPA, 1997 a., Tier 1

④ EPA, 1997 b., Tier 2

⑤ EPA, 1998, Vendor C, Round 2

Exhibit 9 Soil Action Level Goals① as Determined for the American Creosote Site, Jackson, Tennessee②

Chemical	Remedial Action Goal③
Arsenic	225
Benzo(a)pyrene	41.5
Dibenzo(a,h,)anthracene	55.0
Pentachlorophenol	3,000
Dioxins TCDD-TEQ	0.00225

1) Level of contaminant in soils at, or above which, remedial action is required.
2) Source EPA 1996b
3) mg/kg - based on lifetime cancer risk future adult worker, $1X10^{-4}$ risk.

Exhibit 10 Solidification/Stabilization Specifications for Remediation of the American Creosote Site, Jackson, Tennessee

Leaching Properties①			
Parameter	**Average All Treated**	**Maximum Any Batch②**	**Method**
Arsenic	<50 μg/L	<75 μg/L	SW846,7061
PAHs (B(a)P Potency Estimate	<10 μg/L	<15 μg/L	SW846,8270
Dibenzo(a,h) Anthracene	<4.4 μg/L	< 6.6 μg/L	SW846,8270
PCP	<200 μg/L	<300 μg/L	SW846,8270
Dioxins TCDD-TEQ	<30 pg/L	< 45 pg/L	SW846,8290
Physical Properties			
Parameter	**Average All Treated**	**Maximum Any Batch**	**Method**
Permeability	$<1x10^{-6}$cm/sec	$<1x10^{-5}$cm/sec	ASTM D5084
UCS	>100 psi	>80psi	ASTM D1633

Leaching Properties①			
Volume Increase	<35 percent		

1) Synthetic precipitation leach procedure, EPA SW846, Method 1312
2) Batch size 500 cubic yards

Exhibit 11 Major Bid Cost Components of the Remedial Action at the American Creosote Site, Jackson, Tennessee

Item	Cost Per Unit	Total K$
MOB and Documents	-	142
Demolition/Debris	-	34
NAPL Recovery	System	124
Cutoff Wall	$9 Lin. Ft.②	20
Drainage Trenches	$14.90 cy	75
Excavate, Treat and Replace Soil	$44.25 cy③	1996
Water Treatment	$ 0.68 gal④	20
Creosote Disposal	$ 3.05 gal④	47
CAP (GCL① plus 2 ft. soil)	$ 50,460 Acre	363
Site Restoration and DEMOB	-	55
Other	-	10
Total		2,886

① Geosynthetic Clay Liner Linear Foot
② Linear Foot
③ Cubic Yard
④ Gallon U.S.

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